Common Ground For Laws and Metaphysical Modality

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1. PROPERTIES, LAWS AND MODALITY

1.1 Introduction

Philosophers in general, and metaphysicians in particular, are largely concerned with metaphysical *modality*, that is, with what is possible and necessary, in the broadest sense, and with what makes propositions about metaphysical modality *true*. Metaphysicians are also concerned with *ontology*, that is, with what *exists* and the nature of what exists. Ontology covers such questions as "do numbers exist?" and "do universals exist?" and, if numbers and universals do exist, "what are they like?" and "*how* do they exist?". The laws of nature, such as the law of universal gravitation, Coulomb's law and the Schrödinger equation, for example, raise interesting philosophical questions at the intersection of metaphysics and the philosophy of science, such as "what is the relationship between laws of nature and scientific explanation?" and "in what sense, if any, are we free to break the laws?".

Questions about modality, ontology and laws of nature connect in interesting ways. The kinds of things – propositions, universals, possible worlds, etc. – that one is willing to countenance will impact what one can say about the metaphysics of modality and natural laws. The point is illustrated nicely via consideration of *Humean* constraints on respectable ontology popularized by David Lewis and the ensuing metaphysics of laws and modality that Lewis defends.[1]

Characteristic of *Humean* ontology is the disavowal of metaphysically necessary connections between distinct, intrinsically typed, entities (see, e.g., Wilson 2010). The ontology that Lewis defends, *Humean Supervenience*, conceives of the world as just a vast, contingent, 4-dimensional array of perfectly natural, intrinsic properties of, or instantiated at, space-time points, and the spatiotemporal relations between them. The characteristic absence of necessary connections between distinct existences is cashed out by maintaining that no perfectly natural, intrinsic property instance implies anything about any other property instance. Properties are

[1] Hale (2013) also argues for mutual dependence between ontology and modality.

instantiated and stand in the spatiotemporal relations that they stand in, but no property instance metaphysically necessitates the existence of any other property instance nor does it metaphysically necessitate the relations in which any other property instance stands. Jacobs (2010, 229) calls this requirement *independence*. The 4-dimensional array of *independent* property instances is sometimes referred to as the Humean *Mosaic* (1986, ix–x; 1994, 474).

Lewis describes Humean Supervenience as "another speculative addition to the thesis that truth supervenes on being"(1994, 474); any truths must be made true by the thoroughly contingent spatiotemporal arrangement of perfectly natural, intrinsic properties of, or instantiated at, space-time points. This includes truths about *modality* and truths about the *laws of nature*.

The Humean's supervenience base, however, seems to lack enough stuff to properly account for the metaphysics of modality. This famously led Lewis to outsource modality to other concrete, but spatiotemporally and causally isolated worlds (e.g., 1986). Heil makes this point: "Such a universe [i.e., a Humean one] would seem to want the resources needed to make modal truths true. In response to this deficit, Lewis introduces the apparatus of possible worlds…"(2015, 42). Vetter makes a similar point: "Possible worlds provide a viable way for the Humean to 'outsource' modality: it is still a matter of deeply non-modal facts; we simply need enough such facts." (2015, 7). As does Jacobs: "…the defender of independence who thinks there are genuine modal facts about the world is forced to look elsewhere, beyond the concrete actual world and its inhabitants, for truthmakers for modality. In addition to this world, there are many other, merely possible worlds." (2010, 229). Humean ontology and Lewisian modal realism are thus intimately connected, the tether being the requirement to make sense of, by providing truth conditions for, *modal* propositions.

Natural laws appear to carry modal force and hence appear to be in tension with Humean supervenience and its commitment to independence. A law according to which, say, "all Fs are Gs", in virtue of its being a *law*, seems to imply that the properties F and G are not independent because F's being instantiated

necessitates G's being instantiated. The law seems to impose a necessary existential connection between the properties F and G.

According to Lewis, however, laws of the form "all Fs are Gs" are nothing more than regularities in the pattern of independent property instances throughout the Humean mosaic. What distinguishes lawful from non-lawful regularities, according to Lewis, is the fact that the former, but not the latter, are axioms of the description of all property instances throughout the Humean mosaic, which maximizes the virtues of informativeness and simplicity. This is the crux of Lewis's *best system analysis* of natural laws (BSA) (see, e.g., Lewis 1983, 1994, 2001; Earman 1984; Loewer 1996). Natural laws are thus accounted for in a manner that the Humean finds metaphysically innocuous because no appeal is made to any mysterious governing forces or necessary connections between distinct existences. The criterion for law-hood, according to the BSA, that a regularity feature as an axiom of the best systematization of all property instances, does not violate independence. It follows that the laws are thoroughly contingent on Lewis's account; had the contingent pattern of independent property instances been different, the laws would have been different too.

Accounting for laws and modality presents a distinctive challenge for the neo-Humean defender of independence and on both fronts a cost is incurred; matters of fact *beyond* the actual world must be invoked to provide truthmakers for modal propositions,[2] and the idea that the laws hold of any kind of *necessity* must be given up. One might thus wonder if the benefits, whatever they may be, of a Humean ontology justify these costs.

The Humean is primarily concerned with defending (the tenability of) an ontology, which then informs and places restrictions on what can be said about laws and modality. However, one's primary concern might just as well be with analysing the laws and, dissatisfied with regularity accounts, such as the BSA, one might be motivated to develop an alternative account of laws with its own distinctive ontological implications. Armstrong (1999) famously introduced second-

[2] Alternatively, the neo-Humean *actualist* may appeal to a plethora of actual yet *abstract* objects to account for modality. But this strategy is costly in its own way and, arguably, less theoretically fruitful than full-blown Lewisian modal realism (see, e.g., McMichael 1983; Lewis 1986).

order *necessitation relations* between universals (see also Dretske 1977; Tooley 1977) in an effort to capture the type of necessity distinctive of natural laws.

According to Armstrongian accounts, a law of the form "all Fs are Gs" holds in virtue of a *necessitation relation* between the universals F-ness and G-ness. The necessity of the law "all Fs are Gs" is then understood as conditional upon the instantiation of the relevant higher-order necessitation relation. Alternatively, *dispositional essentialists* (e.g., Ellis 2001; Bird 2007), have argued that fundamental properties are best understood as essentially and irreducibly modal *producers* of certain behaviours. According to this account, the property *charge*, for example, is essentially such that any charged individual is disposed to exert a force on all other charged individuals and it is this fact about the nature of the property *charge* that then grounds *Coulomb's law*. Dispositional essentialism thus renders laws necessary conditional upon the instantiation of the relevant properties. Novel ontological posits such as necessitation relations and dispositional essences have thus been invoked to account for laws of nature and to endow the laws with certain desirable features (such as necessity and explanatory power) that are arguably *not* captured by the BSA, or even *capturable*, within a sparse Humean ontology.

Beebee (2000) has argued that many criticisms of the BSA, and hence motivations for alternative accounts of laws, such the Armstrongian view or dispositional essentialism, subtly beg the question by smuggling in conceptions of natural law explicitly rejected by proponents of the BSA. Another way of interpreting the situation might see it as a standoff between competing pre-theoretical conceptions of laws. Those according to whom the laws must play a metaphysically substantial role in the unfolding of events in the universe will be unimpressed by the BSA and compelled to introduce whatever ontological elements are required to satisfy their conception of natural law. Hence, one's pre-theoretical commitments to a certain conception of the laws of nature can just as well inform one's ontology as the other way around.

Similarly, convictions about the metaphysics of modality might inform one's ontological convictions. A kind of extreme scepticism about the legitimacy of modal notions might seem naturally allied with something like a Humean ontology that

recognizes no necessity, or indeed related notions, like essences and dispositions, in nature. Lewis, however, was not this kind of sceptic; he believed in modal facts. His Humeanism then forced him to ground these facts outside of actuality, which led to his modal realism. However, one might share Lewis's modal anti-scepticism but be less than impressed by the "non-standard cosmological theory" (Williamson 2013, xii) he invokes to account for modal truths. In this case, it might seem natural to modify one's ontology appropriately such that the actual world may serve as a suitable ground for facts about modality. In this case, one's convictions about matters modal might serve to inform one's ontology more broadly.

The point, then, is that issues concerning laws, modality and ontology are often closely related and what one wishes to say on any one of these issues will have implications for what one can or must say about the others. It would be too quick, however, to assume that questions about any one of these three issues must be settled prior to the settling of questions about the others.

My concern in this thesis is with exploring the interactions between a cluster of specific views about ontology, modality and the laws of nature. The particular ontology I am interested in is unHumean in the sense that it admits necessary connections between properties and the behaviours that they confer because properties have non-trivial *essences* which *ground* certain behaviours. The account of laws is metaphysically thin for it conceives of the laws as merely descriptive, *à la* the BSA. And the metaphysics of modality that I am interested in roots modality firmly in the *actual* world.

As it happens, I will first offer some preliminary reasons in support of the ontology under consideration (though the details will be developed in subsequent chapters), before then showing how that ontology naturally allies with the particular accounts of metaphysical modality and the laws of nature also to be considered. My discussion proceeds from ontological considerations to other metaphysical considerations, namely those concerning modality and natural law. In this respect, my inquiry might seem somewhat Lewisian in spirit, given that he tells us that much of his work "could be seen in hindsight as a campaign on behalf of "Humean Supervenience"" (Lewis 1994, 473; Lewis 1986, ix–xvi). However, as shall

become evident, many of the details are distinctly unLewisian for being distinctly unHumean.

I do not take it to be the case that the order of explanation must be as it might appear from the structure of my discussion, particularly in the case of the ontology-modality pair; it is certainly not that I think that the metaphysics of modality must be thus and so just because it follows from what I think about the ontology. I find the views about ontology and modality to be discussed independently very attractive and hence I take them to be further strengthened by their coherence. When it comes to the laws of nature, the situation is not quite so clear. I certainly lack any strong, pre-theoretical views on what an analysis of the natural laws might look like. For example, I have no strong intuitions on whether it is part of the concept of laws that they govern/determine events (see, e.g., Mumford 2004 who thinks that "real" laws have a governing/determining role. See also Beebee 2000 and Bird 2007, pp. 189-198 for discussion of the competing intuitions) as opposed to, say, merely describing them. So, the analysis of laws that I propose is probably best thought of as explanatorily posterior to the views about ontology and modality suggested, the features of which I use to inform the account of laws.

My aim in this thesis is partly to defend the particular views about the metaphysics of properties, laws and modality, which I find independently plausible. My aim is also to build a case for this particular package of views by showing it to be more philosophically fruitful than the sum of its parts. It would be beyond the scope of the inquiry to provide a comprehensive treatment of all of the philosophical issues concerning laws, modality and ontology separately so, inevitably, interesting corners of the debates about these topics will be skimmed over or omitted all together at times. I think that this is justified, however, given that I am interested in developing one particular package of views of laws, ontology and modality and showing the kind of virtues that it is apt to yield. I don't intend to argue that there are no other packages out there that would be worthy of consideration or even, perhaps, better than the package that I put forward here. I aim to develop a particular package and demonstrate its key features and virtues,

not to claim that it is superior to any alternative, for to properly scout out all the alternatives would be too big a task.

Finally, although I suggested that my project, unlike, e.g., Lewis's, is probably not best viewed as primarily a defence of an ontological stance, I do share with Lewis a certain methodological motivation. Lewis's touted motivation for Humean Supervenience, defence of which inspired much of his subsequent metaphysics, was to "resist philosophical arguments that there are more things in heaven and earth than physics has dreamt of" (Lewis 1994, 474). In a similar vein, I am partly motivated to defend the aforementioned package deal by a desire to bring metaphysics and metaphysical inquiry into harmony with science and natural scientific inquiry. I agree with Callender that "metaphysics is best when informed by good science and science is best when informed by good metaphysics" (2011, 48) and have sympathy for "a view of metaphysics that is less guided by armchair speculation and…more intent on investigating, along with the natural sciences" (Contessa 2016, 1244). Ultimately, I will argue that the theoretical benefits of the package deal under consideration to a large extent inhere in its ability to satisfy these methodological scruples. I hope that this point will emerge as the discussion proceeds, but its proper defence will have to be postponed for chapters 6 and 7, once the package has been expounded in some detail.

For the remainder of this chapter, I will introduce a crucial point of disagreement between Humean and unHumean *ontologies* – the metaphysics of fundamental physical properties. And I shall discuss how an unHumean metaphysics of properties, according to which properties are necessarily connected to the dispositions that they confer upon their bearers, stands in relation my favoured actualist modal metaphysics (hardcore actualism). In the next chapter I shall take up the issue of where the natural laws fit in. I shall rule out *dispositional essentialism* (Bird 2007) as a candidate theory of laws and offer a diagnosis of its failure. This shall lead, in chapter 3, to a defence of *qualitative dispositional essentialism* (QDE), according to which properties are *qualities*, which *ground* dispositions. Bird, by contrast, holds a structuralist view of properties according to which the essences of fundamental properties are exhaustively *constituted* by

dispositions. This *structuralist* ontology, however, raises various problems, which QDE can avoid. In chapter 4, I combine my favoured unHumean metaphysic of properties with what some might describe as a *Humean* account of laws, what I will call the Revised Potency-BSA – a variant on the traditional BSA, which incorporates the modal nature of properties. I then demonstrate how this package of view avoids the various problems raised for the dispositional essentialist account of laws and properties. In chapters 5 and 6, I'll further discuss *hardcore actualism* and what results from its combination with the account of laws developed, namely, a highly unified account of laws and modality according to which facts about laws and facts about modality share a common metaphysical *ground*. The laws of nature then turn out to be particularly pertinent summaries of the space of metaphysical possibility with the result that scientific inquiry into the laws of nature is apt to yield metaphysical insights too. In chapter 7, I discuss the epistemological and methodological upshots of the view defended.

1.2 Humeanism and Quidditism

In this section, I'll be concerned with the question, brought to the fore by a history of *Humean* constraints on ontology, of whether and to what extent the world should be thought of as containing any irreducible modality. Ought we think of the world as nothing more than a vast, 4-dimensional, array of perfectly natural, intrinsic, point-sized qualities and the spatiotemporal relations between them, or should we admit more structure in the form of, say, real essences and necessary connections?

Now it might seem that this question could just as well be filed under the heading *"the metaphysics of modality"* as *"ontology"*. Perhaps this is so. As mentioned, this thesis is largely motivated by a concern with the tight relations between ontology and the metaphysics of modality. However, the respect in which I will try to prise apart questions about ontology and questions about the metaphysics of modality is this. When engaged with questions about *ontology*, I will be primarily concerned with *what there is* and the *nature* of what there is, whereas when engaged with questions about the metaphysics of modality I will be primarily concerned what it is *in virtue of which* propositions of the form *necessarily x* and *possibly y*, are

true. Answers to the *what is there*-type questions will often include terms like "necessary", "essential", "disposition" and other terms for *modal* notions. And conversely, the provision of grounds for modal truths will include appeal to features of our ontology. So, there is a sense in which the questions about ontology and modality with which I shall be engaged are related but also a sense in which they are distinct.

After providing some reasons, in this section, for thinking, *contra* Humeanism, that the actual world is irreducibly modal in certain respects, I'll show, in section 1.3, how this ontology is indeed a prerequisite for an independently plausible view in the metaphysics of modality variously dubbed *dispositionalism* (e.g., Vetter 2015; Borghini and Williams 2008) and *hardcore actualism* (Contessa 2010) – I'll use the latter term.

As mentioned, I am sympathetic to Lewis's desire to "resist philosophical arguments that there are more things in heaven and earth than physics has dreamt of" (ibid). However, in recent years much doubt has been cast on the idea that adherence to Humean strictures is the best way to achieve this (e.g., Cartwright 1999; Hawthorne 2001; Bird 2007; Maudlin 2010; Demarest 2017). Lewis's Humean ontological offering, *Humean Supervenience*, conceives of the world as:

> [A] vast mosaic of local matters of particular fact, just one little thing and then another […] an arrangement of qualities. And that is all. There is no difference without difference in the arrangement of qualities. All else supervenes on that. (Lewis 1986, ix).

And central to Humean Supervenience is the absence of any necessary connections between distinct existences. What I want to focus on are the implications of this ban on necessary connections for the metaphysics of those properties that make up the supervenience base.[3]

[3] Armstrong rejects Humean Supervenience by admitting primitive, higher order, *necessitation relations* between universals to account for natural laws. But like Lewis, he maintains a categoricalist view of properties according to which properties are *quiddities* (to be discussed shortly) that are only contingently connected to their causal/theoretical roles (e.g. 1983, 1989, 1997). Thus, much of the discussion that follows will be applicable to the Armstrongian view too.

To properly keep out necessary connections, the fundamental properties constitutive of the Humean's vast "mosaic" must not themselves impose any modal restrictions. They must not stand in any necessary connections to each other or to the behaviours of individuals that instantiate them. As such, an understanding of fundamental properties as *quiddities* would thus seem to fit the bill here, where a quiddity is something like a primitive *thisness* or *haecceity* for a property.

Smith (2016) discerns two (related) forms of quidditism, *individuation* quidditism, I-quidditism for short, and *recombinatorial* quidditism, R-quidditism for short. I'll discuss each of these in turn before showing that R-quidditism entails I-quidditism, but not vice versa, which means that it is only by upholding R-quidditism that the Humean may be sure that no necessary connections between distinct existences are admitted.

According to I-quidditism, what individuates properties is primitive and unanalysable. Thus, Black (2000, 92), uses the word 'quidditism' "for the acceptance of primitive identity between fundamental qualities across possible worlds." According to Barker (2009, 242), "a property possesses a quiddity just in case its identity is fixed by something independent of the causal-nomological roles it may enter into". And according to Schroer (2010, 833) "quidditism is the position that *properties* have a transworld identity that does not depend on their causal powers." (See Smith 2016, 239). Thus, for any two distinct properties, *p1* and *p2*, according to the I-quidditist, no more can be said about what individuates *p1* and *p2* than that *p1* is the property that it is and *p2* is the property that it is and that it is not the case that *p1* = *p2*.

According to R-quidditism, "there are no restrictions on the recombination of properties in metaphysically possible worlds" (Smith 2016, 240). In other words, the connections between quiddities and the behaviours of those objects that instantiate them are thoroughly contingent. Quidditism, Lewis tells us, is to properties as haecceitism is to individuals (2009, 209). According to the haecceist, we can take two distinct individuals, *a* and *b*, swap around all of their properties such that *a* ends up with all the properties with which *b* started and vice versa, thus yielding a different, but qualitatively indistinguishable, situation from that with

which we started (see also Chisholm 1967 for an influential discussion of haecceitism). R-quidditism says a similar thing about properties.

To get a better grip on R-quidditism, it helps to notice that properties have nomological roles, or dispositional profiles (for present purposes it is not necessary to distinguish these notions), which is just to say that properties are associated with certain *behaviours*. I'll use the term *modal profile* to refer to the full range of behaviours with which a given property is associated and I'll talk in terms of properties "having" modal profiles (later, in chapter 4, I'll introduce and work with a more precise understanding of the term *modal profile*). Thus, the modal profile of the property *charge* says that like charges are disposed to accelerate away from one another and that opposite charges are disposed to accelerate towards one another in a very particular way which varies with the magnitude of the instances of *charge*, the masses of those instances of *charge* and their distance of separation. Now take two distinct properties with distinct modal profiles. According to R-quidditism, it is possible to permute the fundamental properties associated with those modal profiles to yield a distinct, but qualitatively indistinguishable, situation from that with which we started (see Lewis 2009, 209–10). Consider, for example, *charge* and *mass*. In this world, *charge* disposes its bearers to interact in accordance with Coulomb's law and *mass* disposes its bearers to warp spacetime – each has a different set of associated behaviours or *modal profile*. R-quidditism sanctions a *distinct* possibility in which these properties completely swap the behaviours towards which they dispose their bearers – a possibility in which *charge* and *mass* swap modal profiles (Bird 2007, 75 considers the example in detail).

Quidditism is attractive to Humeans because its *denial* would seem to bring with it a commitment to necessary connections between property instances and certain behaviours, which makes the Humean squeamish. Anti-I-quidditism would surely require something substantial to be said about the identity of properties – something like non-trivial essences for properties would have to be posited. *Dispositionalism* offers what might seem like an obvious development of this idea.

According to dispositionalism, fundamental properties are individuated on the basis of their modal profiles. Thus, according to dispositionalism, for a given

fundamental property, P, instantiated at the actual world, no property instantiated at any other world, *w*, will count as an instance of P, unless it has the same modal profile at *w* as that had by P at the actual world. Dispositionalists will typically claim that a fundamental property's modal profile is part of its real, as opposed to merely nominal, essence (e.g., Ellis 2001; Bird 2007). Thus, for example, the association between *mass* and a disposition to warp spacetime is not merely an artefact of our usage of the *word* "mass". Rather, the disposition to warp spacetime is part of the essence of the property *mass* itself. If a property, P's, modal profile is part of P's real essence, then an individual, *x's*, instantiating P will *imply* that *x* is disposed to behave a certain way in accordance with the modal profile that is part of the essence of P. By making modal profiles part of the real essences of properties, the dispositionalist countenances necessary connections between property instances and the behaviours constitutive of their modal profiles. For example, if both x and y instantiate positive charge, x and y will be disposed to accelerate away from each other, and they will be so disposed of *necessity* (conditional upon their both continuing to instantiating positive charge). Another way of putting the point is that dispositionalism, which constitutes the denial of I-quidditism, imposes restrictions on how properties are possibly recombined. *Mass* and *charge* cannot swap modal profiles because they have their respective modal profiles essentially, and those modal profiles impose restrictions on the possible space-time distributions of *instances* of *mass* and *charge*.

Now it seems plausible, as indeed Smith highlights (2016, 240), that R-quidditism entails I-quidditism, and hence that the *denial* of I-quidditism entails the denial of R-quidditism. The example of dispositionalism, in the previous paragraph, attests to the latter; by making modal profiles part of the essences of properties and hence individuative of those properties, dispositionalism imposes restrictions on how properties are possibly recombined. Smith argues that in the complete absence of any restrictions on the possible recombination of properties, as per R-quidditism, fundamental properties "cannot be individuated on the basis of their [modal profiles] and (something akin to) I-quidditism must be true" (Smith 2016, 240). Smith's argument can be reconstructed more formally as follows:

i) R-quidditism is true (assumption).

ii) If properties are individuated via their modal profiles, then there are restrictions on how they are possibly recombined (as argued in the previous paragraph with reference to dispositionalism).

iii) If there are no restrictions on how properties are recombined, then properties are not individuated via their modal profiles (contraposing premise ii).

iv) Properties are not individuated via their modal profiles (i, iii, *modus ponens*).

v) If properties are not individuated via their modal profiles, whatever individuates them must be primitive and unanalysable.

vi) I-quidditism is true (iv, v, *modus ponens*).

From the assumption that R-quidditism is true, it follows that I-quidditism is true. Two brief comments on Smith's argument are in order. For one, this argument only shows that *one version* of I-quidditism is true (more on this shortly). And secondly, why should we believe v)? The idea behind v) is that if properties are not individuated by the behaviours/dispositions with which they are associated then whatever individuates them must be primitive and unanalysable because there are no other options. Properties are either individuated by the behaviours/dispositions with which they are associated, or property individuation is a primitive matter about which no more can be said than that properties A and B are distinct iff it is not the case that A and B are identical. The (plausible) thought behind v) is that these options for how properties are individuated are jointly exhaustive.

According to Smith, I-quidditism does not entail R-quidditism. This is because Smith distinguishes the view that she calls *non-recombinatorial quidditism*, according to which the identity and distinctness of properties is primitive and unanalysable, as per I-quidditism, yet those properties still impose restrictions on how they are possibly recombined. Hence the caveat above: R-quidditism implies

one version of I-quidditism, but there is also a version of I-quidditism that is incompatible with R-quidditism.

The important point, then, is that for the Humean who is keen to excise necessary connections between properties and modal profiles and, hence, between property *instances*, it will not suffice to defend I-quidditism. To properly keep out necessary connections, the Humean must uphold R-quidditism, as indeed Lewis (2009) does. Lewis elaborates on R-quidditism in some detail. I present Lewis's view in the next subsection before moving on to consider the plausibility of the quiddistic metaphysic of properties that the Humean seems forced to uphold.

1.2.1 Lewis on R-quidditism

Lewis (2009) explores R-quidditism in terms of the multiple realizability of a scientific theory. Imagine the (hypothetical) complete final theory of the world, T. We can assume, following Lewis (2009, 206), that the theory, T, consists of all the logical consequences of a sentence, which we might call the *postulate* of T. We can denote the postulate as follows: $T(t_1,\ldots,t_n)$. Where the $t_1,\ldots,t_n$ are theoretical terms (T-terms), including, perhaps, 'mass', 'charge' and 'spin', among others sufficient to provide "a true and complete inventory of those fundamental properties that play an active role in the actual workings of nature" (Lewis 2009, 205).

Lewis notes that scientific theorizing has gone hand in hand with the discovery of fundamental properties; "For instance the discovery of the phenomena of electromagnetism and the laws governing them was inseparable from the discovery of the previously unknown, and very likely fundamental, properties of positive and negative charge." (2009, 205). The point, then, is that among the T-term referents will be all of the fundamental *properties*. The postulate is also made up of a lot of (what Lewis calls) old language (O-language), which suffices to express all possible observational evidence and which is available independently of our theoretical-term introducing theory T. The *Ramsey sentence* of our theory, T, replaces T-terms in the postulate with variables bound by existential quantifiers. Thus from, $T(t_1,\ldots,t_n)$ we get $\exists x_1,\ldots,\exists x_n, T(x_1,\ldots,x_n)$. The result is a sentence, which defines the theory's T-terms implicitly in terms of each other and the non-theoretical O-

language. In other words, T-terms are defined by their position in the Ramsey sentence, which is tantamount to saying T-terms are defined in terms of modal profiles, *viz.*, the *behaviours of objects* that instantiate the relevant properties. The Ramsey sentence says, further, that *there are* some things associated with those modal profiles.

To illustrate the point with a simpler example, imagine that we were concerned, not with a complete final theory of the universe, but with the theory of a bicycle. Then we might construct a "bicycle postulate" along the following lines:

B: "the pedal is attached to the crank which turns the front gear…"

And so on until we have a sentence sufficient to imply the complete workings of a bicycle. The terms 'pedal', 'crank' and 'gear' in B are T-terms in the context of a bicycle-theory. The Ramsey sentence of B replaces these T-terms with variables and prefixes with existential quantifiers:

RB: $\exists x_1, \exists x_2, \exists x_{3\ldots}(x_1$ is attached to x_2 which turns the front $x_3\ldots)$

RB, the Ramsey sentence of B, thus defines the theoretical terms in B implicitly in terms of each other and what they *do*, or the *behaviours* with which they are associated, in the non-bicycle-theoretic O-language. Furthermore, RB says that there are some things occupying the theoretical roles in the bicycle-theory. The Ramsey sentence of the complete final theory of the universe is like this, except it concerns the entire universe as opposed to a bicycle; it defines property terms such as 'mass' and 'charge' in terms of the behaviours associated with the denoted properties in relation to other properties. In other words, theoretical terms are defined in terms of modal profiles.

According to Lewis, there are genuinely different possibilities corresponding to, qualitatively indistinguishable, different realizations of the Ramsey Sentence of the complete final theory. That is to say, properties are free to recombine with different modal profiles, as per R-quidditism. And since what individuates

properties is not their modal profiles, I-quidditism would seem to follow (see above and Smith 2016, 240). There is, then, a quiddistically different possible world in which wherever we would point to stuff engaged in what *we*, having been brought up in the actual world, would call distinctively *massy* behaviour, it will be whatever we would normally call *charge* at the actual world that is picked out, and vice versa, because the properties, *charge* and *mass* have swapped modal profiles. The possibility imagined is qualitatively indistinguishable from the situation at the actual world but nonetheless *quiddistically* different.

Could there be a merely quiddistic difference in the bicycle case too? Could there be, say, a case in which a pedal plays the gear role and a gear plays the pedal role – that is to say, a case in which an individual instantiating the property *pedal-ness* behaves like a gear, and vice versa. Such a possibility will likely strike us as very strange indeed. A pedal and a gear, in virtue of instantiating the properties *pedal-ness* and *gear-ness* respectively, just don't seem to have the appropriate physical make up to play each other's roles in the bicycle. We could, of course, melt down the respective *individuals* and recast them in a shape appropriate to play a new role. But once the pedal is cast into the shape of a gear and installed in the bicycle ready to do the work of a gear, it would seem very odd indeed to say that there is any sense in which this thing behaving in a way that we associate with being a gear is nonetheless still a pedal and hence that a pedal is playing the gear-role. The question is not whether the *individuals* instantiating *pedal-ness* and *gear-ness* could swap properties and hence play each other's role in the bicycle, but whether the properties themselves could switch roles. The latter suggestion seems implausible because nothing, it would seem, about the property *pedal-ness* is retained when the pedal is recast into a gear-shape and assigned the gear-role in the bicycle. But it is something analogous to this that the R-quidditist thinks *is* possible in the case of fundamental properties. Properties, according to R-quidditism, are quite independent from their modal profiles, independent, that is, from the behaviours of those objects that instantiate them. So, the property *mass* might be "recast" into the *charge*-role, because something, a *quiddity*, is common between instances of *mass* pre and post role reassignment.

1.2.2 Implications of Quidditism

Lewis (2009) draws a sceptical conclusion from his discussion of R-quidditism; since all we can ever have epistemic access to are modal profiles – that is, what properties dispose their bearers to *do* in various circumstances – and since knowing a modal profile is insufficient to know what property has that modal profile, because properties can switch modal profiles, we are ineffably ignorant of the *properties in themselves*. Lewis embraces this conclusion, quipping that no one ever promised him that he was capable, in principle, of knowing everything. Others, however, have seen the ineffable ignorance ushered by R-quidditism as cause for concern.

By highlighting the possibility that multiple properties have the same modal profile, Bird (2007, 77–78) presents an even more worrisome sceptical implication of R-quidditism . Given R-quidditism, it is possible that two or more properties have the modal profile that we associate with the term 'mass'. Furthermore, we cannot know if such a possibility is indeed realized at our world because there would be no detectible difference between a world in which just one property plays the mass role and a world in which multiple distinct properties play the mass role. A plausible conception of *mass* as *the* property with such and such a modal profile and hence which occupies the mass role would be undermined if *two or more* properties occupied mass role. And since we cannot know whether or not two or more properties occupy the mass role, we cannot know whether this plausible conception of *mass* is undermined. Furthermore, if, as again seems plausible, we fix the reference of the term 'mass' via the definite description 'the property that fills the mass role', then the possibility that ours is a world in which multiple properties fill the mass role means that we cannot know if our term 'mass' refers to anything at all. An inability to know if our concept of *mass* is undermined or even if our term 'mass' is referential presents a further sceptical worry in addition to an inability to know *the property it itself*. Such considerations, according to Bird, do "serious damage to our concept of a property" (2007, 77) and Bird concludes that since we do not want our metaphysics of properties to condemn us to necessary ignorance of those properties, we should reject quidditism (2007, 78).

Besides the potential sceptical worries that it ushers, quidditism conflicts with the intuition that there can be no distinctions without difference. As Lewis notes (2009, 209), to harbour this intuition is to feel some sympathy for nontrivial principles of identity of indisicernibles (see also Black 2000, 93). Furthermore, *physics* does not seem to need to recognise such things as quiddities, that is, properties which are thoroughly independent of their modal profiles, which brings with it a certain irony given that Lewis' touted motivation for Humean Supervenience was to resist the temptation to posit any entities that physics can do without.

Demarest (2017), following Cartwright (1999), argues that scientists look for "dispositional essences, or what it is that things *do* in different situations" (2017, 48). Experimental set ups are often designed to isolate and observe the characteristic behaviour produced by a single fundamental property. Demarest takes this as evidence for the claim that "physicists aim to discover the characteristic behaviour…of a specific kind of property…" (2017, 48) and she argues that such properties are best thought of as essentially connected with their characteristic behaviours because "Scientists need only perform a relatively small number of experiments on a single kind of particle before they feel confident that they have captured […] the essential dispositions of its potencies" (ibid) where *"potencies"* are fundamental properties that essentially dispose their bearers to behave in certain ways. This kind of argument, according to which all of the properties that science tells us about are *essentially* dispositional (see, e.g., Blackburn 1990, 63; Ellis and Lierse 1994, 32), has been particularly influential in the debate between quidditists and dispositionalists. Why, as Hawthorne puts it, "posit from the armchair distinctions that are never needed by science?" (Hawthorne 2002, 369). *Quiddities*, Hawthorne suggests, are in no way required to make sense of the world so we are best off without them. According to many, then, it is certainly beginning to look as if it is the Humean defender of quidditism who is guilty of supposing there to be more in heaven and earth than physics has dreamt of!

Not everyone is convinced by the sceptical concerns (e.g., Schaffer 2005) nor by the considerations from scientific practice (Psillos 2006b; Locke 2012) that

purport to tell against quidditism. Perhaps, however, one should be less concerned with sceptical arguments and intuitive concerns about distinctions without difference that science can do without and more concerned with the thought that the rejection of quidditism is a natural way to imbue the world with modality, which can then be put to work in a variety of interesting and useful ways. Thus, a more robust motivation for denying quidditism may arise given the conjunction of whatever plausibility the above considerations against quidditism have with the theoretical utility that results from embracing something more akin to dispositionalism.

Dispositional essentialists like Ellis (2001) and Bird (2007) have put the modality yielded by the disavowal of quidditism to work in providing an account of the laws of nature (though I shall criticize the dispositional essentialist account of laws in the next chapter before presenting my alternative account of the relationship between properties and laws in chapter 4). Others have used modal properties to provide an account of metaphysical modality more generally (see Borghini and Williams 2008; Jacobs 2010; Vetter 2015; Bird 2007, n. 146). Modality is a notion of central philosophical importance and I for one would rather embrace this notion as part of the actual world than either deny its intelligibility or "outsource" it to spatiotemporally isolated or abstract worlds, as would seem to be the primary options open to the Humean. My aim, in this thesis, is to explore the interactions between laws and modality given an account of each in terms of properties which, contrary to R-quidditism, are necessarily connected with their modal profiles. Importantly, it turns out that nothing abstract or otherwise unscientific is required to account for laws and modality once both are accounted for in terms of science-friendly modal properties. The relationship thus yielded between laws and modality then has the potential to reconcile metaphysical and scientific inquiry, or so it shall be argued in chapters 6 and 7.

I shan't say any more, in this chapter, about the metaphysics of properties than that, contrary to R-quidditism, I *do* take properties to be necessarily connected with their modal profiles. A crucial point of debate concerns how this necessary connection arises. Dispositional essentialists, such as Bird (2007), take modal

profiles to be constitutive of the essences of properties. Another view, that I'll refer to as *qualitative dispositional essentialism* (QDE) (Tugby 2012), holds that property essences are qualitative grounds of modal profiles. In chapters 2 and 3 I'll discuss the subtleties of these anti-quiddistic views in detail and argue in favour of QDE. But for now, suffice it to note that contrary to R-quidditism, and partly motivated by the above concerns for R-quidditism, I take there to be necessary connections between properties and their modal profiles.

For the remainder of this chapter, I shall further motivate this unHumean ontology that the rejection of R-quidditism avails us of by sketching out how it meshes with an independently attractive account of the metaphysics of modality that I'll call *hardcore actualism*. In chapter 4, I provide an account of laws in terms of the unHumean metaphysic of properties that I further develop in chapter 3. And in chapters 5 and 6, I explore the resultant relationship between laws and modality given an account of each in terms of properties that are necessarily connected to their modal profiles because they *ground* those modal profiles.

1.3 Hardcore Actualism

In this section, I'll briefly discuss *actualism* in the metaphysics of modality before introducing a recent development of this view, which Contessa (2010) has called *hardcore actualism*. I'll outline some of the benefits of hardcore actualism and, linking back to the previous section, I'll discuss the relationship between hardcore actualism and an anti-quidditist ontology. The discussion of this section thus constitutes additional grounds for rejecting R-quidditism in favour of the view that properties are necessarily connected with their modal profiles, for if one finds hardcore actualism attractive, then one should be further persuaded by the ontology required to make it work.

1.3.1 Actualism and Possibilism

Actualism in the metaphysics of modality stands in contrast to *possibilism.* The actualism vs. possibilism debate is a complex one with many nuances and plenty of

scope for confusion.[4] I'll thus keep my discussion here brief, hopefully saying just enough about actualism to provide a suitable entry point into a discussion of *hardcore* actualism.

In a nutshell, actualists believe that everything is actual, where 'everything' is completely unrestricted. Possibilists, on the other hand, think that besides the actual things, there are some merely possible things. To get a better sense of what is at stake here, assume that a talking donkey is a metaphysical possibility, i.e., that the proposition *possibly there exists an x such that x is a talking donkey* is true and that there are, in the actual world, no talking donkeys. Actualists and possibilists have available to them different answers to the question: what makes it true that *possibly there exists an x such that x is a talking donkey*? Possibilists may say that there is some merely possible talking donkey, which could have been actual, and which makes it true that *possibly there exists an x such that x is a talking donkey*. Actualists deny that there are any merely possible individuals besides all the actual individuals, so this answer is not available to them. The actualist only has recourse to the resources of the actual world and so they might, for example, pick out a given non-talking donkey and say that it is metaphysically possible that *it* was a talking donkey and that this is what makes it true in general that there could have been a talking donkey.

Difficulties arise for the actualist, however, when it comes to accounting for possibilities with no such *witness* in the actual world (see also Menzel 2017). Imagine, for instance, a species of *aliens*, so different from anything anywhere in the actual universe that there is no individual which is such that it could have been an alien any more than you or I could have been a poached egg (a plausible *essentialist* assumption). We might nonetheless want to say that it is possible that there were aliens. Now the possibilist can again say that *possibly there exists an x such that x is an alien* is true in virtue of the existence of some merely possible aliens. However, the actualist cannot employ a similar strategy to before of pointing to some actual life form and saying that *it* is possibly an alien because, by hypothesis, aliens are so

[4] Williamson (2013) argues that it is so confused that it is best replaced by a contingentism vs. necessitism debate, that is, a debate over the truth of the proposition that everything is necessarily something.

different from anything in the actual universe that no actual individual is possibly an alien.

Alternatively, if you find the example with aliens unconvincing, consider the proposition *possibly there exist more individuals than there actually are*. Again, the possibilist can say that this is true in virtue of the existence of some merely possible individuals, which could have been actual. But this answer is not available to the actualist and, what is more, none of the actual individuals are such that they could make it true that there could have been more individuals than there actually are. These sorts of cases have led some to appeal to abstract entities (e.g., Plantinga 1976; Stalnaker 2003, 2012) and others to appeal to so-called contingently non-concretia (e.g., Linsky and Zalta 1994; Williamson 1998, 2013), as their modal truthmakers, where both abstract and contingently non-concrete entities nonetheless occupy the *actual* world. A particularly popular actualist strategy in this vein is to try to render possible worlds semantics actualistically acceptable by conceiving of possible worlds as abstract objects, such as maximal properties or maximally consistent sets of propositions (see, e.g., Adams 1974; Plantinga 1976; Stalnaker 2003), all of which are contained within the actual world. The actualist may then say that aliens exist according to some actually existing abstract possible world and that it is in virtue of this that *possibly there exists an x such that x is an alien* is true. So, where possibilists avail themselves of all manner of merely possible individuals in their modal metaphysics, actualists maintain that absolutely everything is actual and so are limited by the resources of the actual world when it comes to accounting for the truth of modal propositions.

1.3.2 Further Restrictions and the Anti-Quidditist Connection

Hardcore actualism imposes the further restriction that only *concrete* constituents of the actual world may serve as truthmakers for modal propositions. It is thus no part of the hardcore actualist's ambitions to provide an account of abstract possible worlds. Possible worlds do not *make* modal propositions true, on this view, though they might provide a useful fiction or heuristic when considering matters modal.

Various articulations of HA all roughly start with the idea that dispositions are connected with possibilities, either via a link with counterfactuals (Borghini and Williams 2008; Jacobs 2010) or directly (Vetter 2015). Thus, if x is disposed to φ, then φ is possible. Since the connection between dispositions and possibility is conceptual, this is something that even the Humean R-quidditist can agree with. But we can distinguish *dispositions* from dispositional *properties*. Dispositional properties *confer* dispositions; thus, the dispositional property *fragility* confers on its bearers a disposition to break. Where Humeanism and hardcore actualism disagree, then, is over what explains what; do dispositional properties explain the presence of corresponding possibilities, or do possibilities explain the presence of corresponding dispositional properties?

For HA, it is the dispositional properties of concrete individuals that explain possibilities. For example, it is possible that a given vase, v, breaks. And what makes this true, according to HA, is the fact that v instantiates the dispositional property *fragility*, whose manifestation is *breaking*. For, e.g., Lewis, by contrast, it is the fact that v breaks in some nearby possible worlds, i.e., some *possibility*, which explains v's fragility. The general hardcore actualist idea can be captured as follows:

> **HA schema**: Possibly φ iff there exists[5] some x, which instantiates a dispositional property whose manifestation is, or includes, φ.

Possibilities, according to HA, are made true by the dispositional *properties* of concrete individuals in the actual world. But if the connection between dispositional properties, such as *fragility*, and dispositions, such as the disposition to break, were thoroughly contingent, as per R-quidditism, then even granting the (conceptual) link between dispositions and possibility, dispositional properties themselves would not suffice to make the corresponding possibilities true. For the R-quidditist, v's instantiating *fragility* need not make it the case that v is disposed to break, and hence need not make it true that it is possible that v breaks, because there is no necessary connection between the property and the disposition. So, v's

[5] Where all that exists is what *actually* exists.

being fragile would not in and of itself suffice to make true the corresponding modal claim that it is possible that v breaks. To explain the possibility that v breaks, the R-quidditist must appeal to more than just v's fragility in order to fill the gap between instantiating some property and being disposed to φ and hence φ's being possible – hence Lewis's appeal to possible worlds. For Lewis it is possible that v breaks, not *in virtue* of the fact that v instantiates *fragility*, for, according to Lewis, v may instantiate *fragility* and yet not be disposed to break. Rather, it is possible that v breaks because there is some *possible world* in which v breaks. And this fact about possible worlds is what makes it true that v is disposed to break and hence makes it true that it is possible that v breaks. HA reverses this order of explanation – it is the property which explains the disposition to break and hence the possibility of breaking.

In order to account for the truth of a disposition ascription, and hence the truth of a corresponding *possibility* in terms of a property, HA cannot allow that the connection between property and disposition is merely accidental, as per R-quidditism. Rather, HA must posit a necessary connection between property and disposition in order to ensure that the instantiation of the relevant property suffices for the truth of the relevant disposition ascription and hence the truth of the corresponding possibility. Hence, HA must deny R-quidditism. Of course, the question remains as to what explains the necessary connection between property and disposition and different ways of denying R-quidditism will disagree on this. Dispositional essentialists (e.g., Mumford 2004; Bird 2007) will say that dispositions are contained within properties' *real essences*, and hence that there is a necessary connection between a property and whatever dispositions constitute its real essence. Qualitative dispositional essentialism (QDE), on the other hand, maintains that properties *ground* dispositions. In chapter 3, I'll argue in favour of the latter. But for now, suffice it to note, that if, as per HA, one wants to account for the truth of modal propositions in terms of dispositional properties of concrete individuals, one must admit that dispositional properties are necessarily connected to dispositions (and hence to possibilities), which is to say that R-quidditism must be denied.

1.3.3 Vetter's view and Implications for Metaphysical Inquiry

To get a better grip on hardcore actualism, and its broader philosophical implications, it will help to briefly consider the details of Vetter's particularly well-developed version of the view. Vetter does more than anyone to explain how the hardcore actualist might capture the full range of modal propositions that we would like our modal metaphysics to capture.

Vetter points out that *dispositional* properties constitute too narrow a class of entities to properly account for the full range of modal truths. According to hardcore actualism, the truth of, e.g., <possibly this vase breaks> may hold in virtue of a dispositional property (*disposition* for short from now on) of the vase, namely its *fragility*, whose manifestation is the state of affairs *the vase's being broken*. But there are many other true modal propositions for which there appear to be no such dispositions grounding their truth. Consider, <possibly this brick breaks>, which is true even though we probably would not want to describe the brick as *fragile*. The brick surely *can* break and this is what makes the proposition <possibly this brick breaks> true, but it does not seem correct to say that the brick is *disposed* to break, that it is *fragile.* Vetter thus posits an ontology of modal properties that she calls *potentialities*, which are similar to the more familiar dispositions. Potentialities and dispositions are related in the following way: potentialities admit of degrees such that to qualify as possessing some *disposition*, an individual must possess the relevant potentiality to a sufficiently high degree (Vetter 2015, 81). So, dispositions, according to Vetter, constitute a subclass of potentialities. Both a vase and a brick have the *potentiality* to break. But only the vase possesses this potentiality to a high enough *degree* to count as being *disposed* to break.

Vetter's hardcore actualism then seeks to ground all truths about metaphysical modality in the *potentialities* of actually existing concrete individuals such that, roughly, a modal proposition <possibly *p*> is true iff something has the potentiality for it to be the case that *p*. It follows that <necessarily *p*> is true iff nothing has the potentiality for it to be the case that not-*p.* Vetter thus anchors all metaphysical modality in localized modalities, namely the *potentialities* of concrete, actual, individuals. The account is realist about modality in that it takes facts about

modality to be mind independent. Furthermore, it does not seek to reduce the modal to the non-modal, rather it seeks to explain all metaphysical modality in terms of a single modal notion: potentiality.

To account for the full range of modal truths, Vetter extends the notion of potentiality in various ways. First, she introduces joint potentialities; Vetter does not herself have the potentiality to play a duet but she does have the relevant *joint* potentiality, with *Jess*, to play a duet. The truth of <possibly Vetter plays a duet> is then grounded in this *joint* potentiality. Furthermore, joint potentialities ground *extrinsic* potentialities and allow potentiality attributions of the form *x has the potentiality to be such that p*. Vetter's potentiality to play a duet is extrinsic, because it concerns some individual external to her, namely Jess, and it is grounded in the relevant joint potentiality of Vetter and Jess to play a duet. But we might also attribute to Vetter the potentiality *to be such that Jess plays a duet.* This potentiality is also grounded in the joint potentiality of Vetter and Jess to play a duet but is of the form *x has the potentiality to be such that p* as opposed to *x has the potentiality to F.* Potentiality attributions of this form are important to Vetter's formulation of the logic of potentiality. Finally, Vetter introduces iterated potentialities; Vetter does not now have the potentiality to have a piano-playing granddaughter but she does have the relevant *iterated* potentiality. Vetter has the potentiality to have a daughter who has the potentiality to have a daughter who has the potentiality to play the piano. The truth of <possibly Vetter has a piano-playing granddaughter> is then grounded in this iterated potentiality. Given that *potentiality* includes joint, extrinsic and iterated potentialities, the essence of Vetter's hardcore actualism can be captured as follows:

> POSSIBILITY: It is possible that $p =_{df}$ Something has an iterated potentiality for it to be the case that *p*. (Vetter 2015, 247)

Hardcore actualism is naturally wedded with a view of the world as imbued with irreducible modality as is the case once R-quidditism is rejected. Given an ontology of potentialities that are necessarily connected with various possibilities,

nothing more is needed – no possible worlds or sets of propositions – to account for modality. So, for anyone convinced by the arguments for rejecting quidditism, hardcore actualism presents a strikingly parsimonious account of the metaphysics of modality. Conversely, the promise of such a simple and sensible modal metaphysics should tempt one who was perhaps not yet ready to give up neo-Humeanism into seriously considering rejecting quidditism and, hence, admitting necessary connections between properties and possibilities.

Hardcore actualism also promises certain epistemological and methodological benefits, which should catch the eye of anyone with naturalistic sympathies. Contemporary metaphysics has largely concerned itself with the metaphysics of modality. For example, Conee and Sider observe that "Metaphysics is about the most explanatorily basic *necessities and possibilities*. Metaphysics is about *what could be* and *what must be*." (2005, 205). Now insofar as the subject matter of modal metaphysics is taken to be abstracta or possibilia and the method of inquiry is taken to be purely *a priori*, those with a naturalistic conscience might question the legitimacy of metaphysics as a discipline – ought not metaphysics, if it claims to be about the most general features of objective reality, make some contact with *science*?

Hardcore actualism vindicates empirical methods of inquiry into modality and, hence, brings metaphysics, more broadly, into harmony with science. Concrete objects and their properties are plausibly the sorts of things that science can tell us about and since the claim is that it is those very objects that ground facts about metaphysical modality, hardcore actualism places *scientific* methods at the centre of the epistemology and methodology of modal metaphysics. Modal metaphysics is no longer primarily concerned with abstracta or possibilia, which, by definition, are *not* accessible via empirical scientific methods. Hardcore actualism thus constitutes a significant step towards achieving continuity between natural science and metaphysics. But this is a substantial point, one which I intend to do no more than briefly flag here; indeed, it is the issue with which I shall be concerned most broadly in this thesis. Subsequent chapters will develop this point by showing how the laws of nature fit into the picture and interact with the modal metaphysics. Ultimately, I'll argue that due to the intimate connection between facts about laws and facts

about metaphysical modality, scientific inquiry into the laws of nature also yields knowledge of metaphysical modality.

1.4 Conclusion

In this chapter, I have outlined my intentions in this thesis, which are to expound the virtues of a package of views about ontology, modality and the laws of nature. I have suggested that the package I propose is apt to vindicate a naturalistic approach to metaphysics because what grounds facts about metaphysical modality are the properties of familiar concrete individuals that we might reasonably expect to acquire knowledge of via natural scientific methods.

I discussed Humean supervenience and argued that the denial of any necessary connections between distinct existences that is characteristic of Humean supervenience carries a commitment to R-quidditism (and hence to I-quidditism). R-quidditism, besides being odd in its own right, risks doing damage to our concept of physical properties if, as seems plausible, they are understood in terms of their modal profiles – *viz.* the characteristic dispositional or nomological behaviours of their instances.

I introduced hardcore actualism (HA), the view according to which modal propositions are made true by concrete property instances in the actual world. And I argued that the denial of R-quidditism is a necessary prerequisite for HA. The independent attractiveness of HA thus constitutes additional motivation for denying R-quidditism and, hence, for admitting that properties are necessarily connected to their dispositional roles. What remains to be explored in the following chapters is how, precisely, this necessary connection between properties and dispositions arises.

The stage is now set for a thorough investigation of the ontology, modality, laws package that I wish to present. The first two components of the package – the ontology and the modal metaphysics –have been introduced in this chapter, but further details of these will emerge in subsequent chapters. In the next three chapters, I'll discuss in more detail the laws of nature and the metaphysics of fundamental properties. Then, in chapters 5, 6 and 7, I'll discuss in detail the

resulting interactions between laws and modality, and the methodological benefits of the resultant package.

2. THE ESSENCE OF THE PROBLEM FOR DISPOSITIONAL ESSENTIALISM

2.1 Introduction

In the previous chapter I outlined my intentions in this thesis, which are to defend and explore a package of views about ontology, modality and the laws of nature. I offered some details of, and motivation for, the particular ontology and metaphysics of modality I wish to defend. The ontology is unHumean because it denies R-quidditism by positing necessary connections between properties and their modal profiles. This is partly motivated by sceptical concerns for, and the objection from science to, the Humean's alternative *quiddistic* view of properties. I then proceeded to argue that the denial of quidditism is naturally wedded with a recent view in the metaphysics of modality called *hardcore actualism* (HA). Once we deny quidditism, HA is poised to provide a strikingly parsimonious account of the metaphysics of modality according to which concrete property instances are the truthmakers for all modal truths. Thus, these views about ontology and modality respectively enjoy independent plausibility and are strengthened by their coherence.

I also want to explore the relationship between an anti-quiddistic view of properties and the laws of nature. Early in the previous chapter, I mentioned that the account of laws that I favour is metaphysically thin for it conceives of the laws as merely descriptive. Indeed, the view of laws that I defend is inspired by and has much in common with Lewis's *best system analysis* (BSA). Where my account of laws deviates from the BSA is that it systematizes not just the *actual* distribution of properties throughout the 4D *Humean Mosaic*, but the actual *and possible* distributions of properties. Development of this account must be postponed for chapter 4. What I wish to do here, on the way to motivating my favoured view of the laws, is critique what might seem to be a natural account of the laws of nature given an anti-quidditist metaphysic of properties, the view that Bird (2007)

develops and does much to defend and calls *Dispositional Essentialism* (DE).[6]

Here is how I'll proceed. First, I'll outline the dispositional essentialist account of natural law found in Bird (2007). This highlights how an anti-quidditist view of properties can inform an account of the laws of nature. Second, I'll present Vetter's critique of DE according to which it fails to account for *functional* laws. Third, I'll present Corry's (2011) *Cartwrightian* critique of DE according to which the ubiquity of *ceteris paribus* laws poses a problem for DE's explanatory aims. I'll then suggest that these two problems for DE are related to a very general, and independently questionable, feature of DE according to which laws are supposedly *constitutive of* the essences of properties which, in turn, are supposed to *ground* those very laws. Hence, I suggest that the relationship between laws and properties requires a radical rethink, which will occur over chapters 3 and 4.

2.2 The Dispositional Essentialist Account of Natural Law

Dispositional essentialism (DE) comprises an account of the metaphysics of properties according to which property essences are constituted by dispositions, and an account of laws of nature in terms of those essentially dispositional properties. In the previous chapter I noted that simply denying quidditism by positing a necessary connection between properties and their modal profiles (*viz.* the dispositions/behaviours with which they are associated) leaves open the question of *how* this necessary connection between properties and dispositions arises. Bird's dispositional essentialist (2007) answer to this question is that properties are necessarily connected with dispositions because dispositions are *constitutive* of the essences of properties. Bird calls fundamental properties with a dispositional essence *potencies* – I will follow Bird's usage of "potencies" in this chapter.

The dispositional essentialist account of laws involves deriving a universal generalization from a statement about the dispositional essence of a potency – *any* individual that instantiates potency, *P*, will be *disposed* to behave in a certain way as

[6] See also Ellis (2001).

prescribed by *P*'s dispositional essence. This derivation is central to the dispositional essentialist account of natural law according to which, roughly:

(DE) *L* is a law if, and only if, *L* is derivable from the essence of a potency.

Let's look at the account in a bit more detail.

According to the simple, conditional analysis, for *x* to possess *the disposition to yield manifestation M in response to stimulus S*, let's denote this "$D_{(S, M)}$", is for *x* to be such that if it *were* S then it *would* be M:

(CA) $D_{(S, M)}x \leftrightarrow (Sx \; \Box\!\!\rightarrow Mx)$

For example, if *x* is disposed to accelerate when in close proximity to negatively charged bodies, then if *x* were in close proximity to a negatively charged body, *e* (stimulus), then *x* would accelerate (manifestation). Bird does not endorse (CA) as an *analysis* of dispositions. Rather, Bird takes (CA) as a necessary equivalence between dispositions and conditionals (2007, 43), which he writes as:

(CA□) $\Box(D_{(S, M)}x \leftrightarrow (Sx \; \Box\!\!\rightarrow Mx))$

So instead of analysing away the disposition, $D_{(S, M)}x$, in terms of a conditional, (CA□) ought to be read as stating the necessary truth that whenever the disposition, $D_{(S, M)}x$, is instantiated, the conditional $(Sx \; \Box\!\!\rightarrow Mx)$ is true, and vice versa.

As mentioned, Bird calls fundamental properties with a dispositional essence, *potencies.* According to Bird, the claim that a property has a dispositional essence can be understood in contrast with *categoricalism* about properties:

> Essentially dispositional properties are ones that have the same dispositional character in all possible worlds; that character is the property's *real* rather than merely nominal essence. Categorical properties, on the other hand, do not have their dispositional characters modally fixed, but may change their

> dispositional characters (and their causal and nomic behaviour more generally) across different worlds. (Bird 2007, 44)

Categoricalism about properties is tantamount to R-quidditism because it says that properties are free to recombine with different *dispositional characters* that is, they are free to recombine with different casual and nomic *behaviours*. Or, as I prefer to put it, properties are free to recombine with different modal profiles. According to dispositional essentialism, by contrast:

> [T]he real essence of some potency P includes a disposition to give some particular characteristic manifestation M in response to a characteristic stimulus S. (Bird 2007, 45).

Since dispositions are part of the *real essences* of potencies, on this view, potencies are *not* free to recombine with different modal profiles and hence R-quidditism is denied.

Bird makes an inference from the above claims about the *real*, as opposed to nominal essence of a potency to a necessary truth: from the claim that *P*, has a dispositional essence he infers that for any world, *w*, and individual, *x*, such that *x* instantiates *P* at *w*, *x* will be disposed to yield manifestation M in response to stimulus S (Bird 2007, 45):

$(DE_P) \quad \Box(Px \rightarrow D_{(S,\,M)}x)$

The truth of (DE_P) thus rests on the assumption that essentialist truths give rise to metaphysical necessities *à la Fine* (1994).

Combining (CA□) and (DE_P) by substituting $D_{(S,\,M)}x$ in (DE_P) for $(Sx \,\Box\!\!\rightarrow Mx)$ then gives us:

(I) $\quad \Box(Px \rightarrow (Sx \,\Box\!\!\rightarrow Mx))$

Where (I) says that, in all possible worlds, if x instantiates P, x would yield manifestation M if it were to acquire stimulus S. Now assume (for conditional proof) that x instantiates potency P and acquires stimulus S:

(II) Px & Sx

From (I) and (II), and with modus ponens for the counterfactual, we can derive:

(III) Mx

It thus follows, by conditional proof, from the assumption in (II) that:

(IV) $(Px \ \& \ Sx) \rightarrow Mx$

And finally, since x is arbitrary, we can generalize, producing:

(V) $\forall x((Px \ \& \ Sx) \rightarrow Mx)$

(V) Is a universal generalization derived from a claim about the dispositional essence of potency. Furthermore, since the reasoning (I) through (V) holds in an arbitrary world, (V) is *necessary* (for additional details see Bird 2007, 43–48):

(V□) $\Box\forall x((Px \ \& \ Sx) \rightarrow Mx)$.

Thus, DE explains the universal generalization in (V) in terms of a claim about the essence of a potency. According to the dispositional essentialist, the laws are those universal generalizations, or *regularities*, which can be so explained in terms of the essence of some potency.

To the extent that they take the laws to be universal regularities, the dispositional essentialist might find themselves in agreement with David Lewis about the nature of natural laws. Disagreement, however, will be over what *explains*

those regularities. For Lewis, all regularities in the world, including the laws, are brute, contingent, facts, and the lawful regularity/non-lawful regularity distinction is metaphysically thin. According to Lewis's *best-system analysis* (1983; 1986; 1994; 2001), the lawful regularities are those whose inclusion as *axioms* in the best systematization of the distribution of properties throughout all of space-time maximizes informativeness and simplicity of that systematization. Since, according to Lewis, the space-time distribution of properties is a thoroughly contingent matter, the laws themselves are thoroughly contingent. The dispositional essentialist, on the other hand, provides an explanation of the distinction between lawful and non-lawful regularities in terms of the dispositional essences of potencies, with the result that the laws are metaphysically *necessary*. DE claims explanatory utility because it distinguishes lawful from non-lawful regularities such that the laws meet certain standards, such as the ability to support counterfactuals and explain their instances, arguably *not* met by the Lewisian regularity theory. Later in his book, Bird is more explicit about what the laws *are*:

> (L) The laws of a domain are the fundamental, general explanatory relationships between kinds, quantities, and qualities of that domain, that supervene upon the essential natures of those things. (2007, 201).

Where, plausibly, (V) schematically expresses the general explanatory relationships holding between the kinds/qualities/quantities *P*, *S* and *M* and which supervene on those things' essential natures, as demonstrated in the derivation of (V) from (I).

Of course, strictly speaking, the conditional characterization of dispositions, (CA□), from which (V) derives, is false. The possibility of finks and antidotes means that there are all manner of counterexamples to (CA□) because an individual, *x*, can be disposed to yield M in response to S, acquire S and yet fail to manifest M. I'll turn to this point in more detail when I discuss Corry's (2011) critique of dispositional essentialism. For now, however, suffice it to note that Bird turns this fact to his advantage. The falsity of (CA□) requires modification of (V) along the following lines:

(V*) $\forall x((\textit{ceteris paribus}\ Px\ \&\ Sx) \rightarrow Mx)$

But we knew that the laws were *ceteris paribus* all along! Like charges, for example, will only accelerate away from each other in accordance with Coulomb's law in the absence of countervailing forces pushing them closer together. Thus, Bird argues that his account has the additional explanatory advantage of showing how the falsity of (CA□) can explain the *ceteris paribus* nature of laws.

Now there is a very general feature of the above account of laws that I think is perhaps implausible, but, more importantly, I take it to be at the root of the criticisms of DE that I shall present in the rest of this chapter. That feature is the idea that particular potency instances fully encode laws of nature, such that a single instance of, say, *charge* suffices to fully ground the associated *Coulomb's law.* Plausibly Coulomb's law *is* a law and hence the sort of regularity that the dispositional essentialist should seek to ground in some potency, the most likely candidate being *charge*. Thus, *charge* must have a dispositional essence from which Coulomb's law derives. More precisely, a true *description* of the essence of *charge* must permit the derivation of a statement of Coulomb's law.

Letting *C* stand for the potency *charge* and substituting *P* for *C* in (I) above, it follows that $\Box(Cx \rightarrow (Sx \ \Box\!\!\rightarrow Mx))$. Now what might we fill in for S and M in the case of *charge*? Whatever we choose must allow for the derivation of Coulomb's law in accordance with steps (I)-(V) above, so perhaps we could substitute S for something along the lines of *…is in close proximity to another charged individual* and M for *…exerts a force proportional to the two charges and inversely proportional to the square of the distance between them.* As it stands, these candidate substitutions for S and M in the case of *charge* are imprecise, certain problems emerge once we attempt to fill in the details, but these will be discussed in the next section of this chapter. For now, I just want to observe the very general point that plausible ways of filling in S and M in the case of *charge* look very much like the statement of Coulomb's law itself. Thus, Coulomb's law, it seems, is supposed to be constitutive of the essence of the property *charge*, according to DE.

My broad concern is that this seems perhaps *too easy* and unexplanatory. It is not clear that one can first build, e.g., Coulomb's law into the essence of charge and then claim to explain Coulomb's law in terms of charge's essence. There is a whiff of circularity here. In other words, it is not clear that it really serves to explain the fact that a certain regularity is a law to just stipulate that those potencies regularly distributed contain the regularity at issue in their *essence*. This is just a rough sketch of the concern at this stage, but I hope to crystalize the issue by examination of some recent critiques of DE. In the next chapter, I shall defend an alternative understanding of the metaphysics of properties which does not simply build laws/dispositions into property essences but which instead maintains that properties are qualitative *grounds* of dispositions.

2.3 Vetter on Functional Laws

Barbara Vetter (2012) provides an incisive criticism of Bird (2007)'s account of the natural laws as grounded in fundamental dispositional properties. In a nutshell, the concern is that DE seems to rule out the possibility of fundamental *functional* laws, which relate *quantities*. Coulomb's law, for example, relates the quantities *force, charge* and *distance* not simply in an on/off manner, rather it says how determinate magnitudes of these quantities vary with one another.

In the previous section, we saw what is meant by the claim, central to DE, that the laws are just those regularities that are grounded in potencies. Steps (I) through (V) show how to derive a universal generalization:

(V) $\forall x((Px \,\&\, Sx) \rightarrow Mx)$

From a claim about the essence of a potency:

(I) $\Box(Px \rightarrow (Sx \;\Box\!\!\rightarrow Mx))$.

Thus, as Vetter puts it, "the grounding of the laws, and the explanation of regularities, is achieved in a most simple and elegant manner: by entailment."

(2012). A universal generalization will count as a *law*, according to DE, if, and only if, it is so entailed by a claim about the essence of a potency.

Cracks begin to appear, however, when we try to fill in the schematic derivation presented in steps (I) through (V) with an actual example. Consider *Coulomb's law* (CL), and the corresponding potency *charge*, in which it is plausibly grounded. We will assume for the sake of argument that <*charge*, Coulomb's law> really is a fundamental property-law pair. According to DE, we should thus be able to derive (CL) from a proposition about the essence of *charge* in accordance with steps (I)-(V). However, (CL) as generally stated:

(CL) $F = \epsilon \frac{eq}{r^2}$

looks rather different from (V). (V), but not (CL), is a universally quantified *conditional*. Thus, if there is to be any hope of deriving (CL) in accordance with the schematic steps (I) through (V) and hence of accommodating its status as a law within the framework of DE, we must reformulate (CL). We can begin to make (CL) and (V) resemble each other by articulating (CL) in conditional form. As a first approximation, we might offer something like:

(CL*) *If x instantiates charge e and is a distance r from another charged individual y instantiating charge q, then x will exert a force on y equal to* $\epsilon \frac{eq}{r^2}$

The schematic "law" (V) tells us only that if x satisfies some conditions (*P* and *S*) it will also satisfy some further condition (*M*); (V) relates *P*, *S* and *M* in a simple on/off manner. However, implicit in (CL*), and absent from (V), is multiple quantification over determinate values of *quantities*, in this case *charge*, *force* and *distance*. This is as should be expected of an attempt to capture (CL) which is a *function* that relates continuous quantities not merely in an on/off manner but via a mathematical operation. For any instance of determinate charge, (CL) tells us exactly how much force it will exert on a distinct instance of exactly how much charge at how great a distance. The challenge, then, is in fleshing out the details of how we are to integrate

the quantitative nature of (CL) into the derivation of (V) from (I) (see Vetter 2012, 211).

We can apply a sort of reverse engineering strategy to this task: first we can attempt to find an instance of (V) that appropriately captures the quantitative nature of (CL) – (CL*) is an informal first shot. From there, we can work out what sort of characterization of charge, i.e., what instance of (I) might allow us to derive the relevant instance of (V). As emphasized, (CL) is a function that relates several quantities. So, an instance of (V) apt to capture this quantitative nature of (CL) will itself have several variables ranging over quantities – (CL*) implicitly quantifies over *charge*, *force*, and *distance*. Now, as Vetter notes, since we don't want any *free* variables, we are presented with two options. Either we fill the variables in with determinates of the quantities related, or we have one, multiply quantified, conditional. For simplicity, Vetter focuses on the derivation of Coulomb's Law from a particular determinate charge: electric charge, or charge *e*: (1.6 x 10^{-19} C). This yields two candidate formalizations of the informal (CL*):

(V-1) ∀x((x has charge *e* & x is $5.3\times10^{-11}m$ from a charge of 1.6×10^{-19}C) → x exerts a force of 8×10^{-8}N)

Or

(V-∀) $\forall x \forall r_i \forall q_i$ ((x has a charge *e* & x is at a distance r_i from charge q_i) → x exerts a force of $F_i = \epsilon \frac{eq_i}{r^2}$)

(V-∀) looks more like (CL) than **(V-1)**. However, due to its multiple quantification, **(V-∀)** isn't an instance of (the singly quantified) (V). Thus, **(V-1)** but *not* **(V-∀)** may be derived from an instance of (I) as the dispositional essentialist would like. The instance of (I) from which **(V-1)** derives is the following:

(I-1) □(x has charge e → (x is $5.3\times10^{-11}m$ from a charge of 1.6×10^{-19}C □→ x exerts a force of 8×10^{-8}N))

Whereas to derive **(V-∀)** we would require:

(**I-∀**) □(x has charge e → **∀**charges q_i **∀**distances r_i (x is at distance r_i from q_i □→ x exerts a force $F_i = \epsilon\frac{eq_i}{r^2}$)

The tension now is that **(I-∀)** but not **(I-1)** adequately characterizes *electric charge*, due to its greater generality. But **(I-∀)** is not an instance of (I), whereas **(I-1)** *is* an instance of (I). To see this, consider the following: in both (I) and **(I-∀)** it is the bit after the first arrow '→' that characterizes charge e. But now we can see the difference between (I) and **(I-∀)** is that the main connective in the characterizing clause in the former is the counterfactual conditional, whereas in the latter it is the universal quantifier (see Vetter 2015, 52). So, the latter, but *not* the former, permits a derivation of an instance of (V) in accordance with the dispositional essentialist account of natural law. We are thus forced to choose between sticking with Bird's account *or* adequately capturing the relationship between *electric charge* and (CL), but, according to Vetter (2012, 212), we cannot do both.

Now we might ask the dispositional essentialist, as Vetter does, which is the fundamental property **(I-1)** or **(I-∀)**, and which is the law to be derived **(V-1)** or **(V-∀)**? Bird suggests an answer to this question when he expresses the view (2007, 22) that *fundamental* essentially dispositional properties, that is, *potencies*, should be characterizable in terms of a single stimulus-manifestation pair linked by the counterfactual conditional. Now the disposition constitutive of the essence of the property **(I-∀)**, is not expressible in terms of a single conditional linking stimulus and manifestation. The disposition essential to **(I-∀)**, namely:

∀charges q_i **∀**distances r_i (x is at distance r_i from q_i □→ x exerts a force $F_i = \epsilon\frac{eq_i}{r^2}$),

is equivalent to an infinite conjunction of highly specific dispositions, like that constitutive of the essence of **(I-1)**, namely:

(x is $5.3\times10^{-11}m$ from a charge of 1.6×10^{-19}C □→ x exerts a force of 8×10^{-8}N).

But, as Bird notes (2007, 22), a conjunction of conditionals is *not* equivalent to a single complex conditional. The disposition constitutive of the essence of **(I-∀)** is irreducibly *multi-track* because it can be analysed in terms of no single conditional linking stimulus and manifestation conditions. So, given Bird's preference for single-track dispositions at the fundamental level (Bird 2007, 22–23), he must consider the property **(I-1)** more fundamental than **(I-∀)**, because the former, but not the latter, has as its essence a *single* conditional linking stimulus and manifestation conditions. Bird must thus consider '**(I-1)** & **(V-1)**' the fundamental property-law pair. But beside his scepticism about multi-track dispositions at the fundamental level, more simply, Bird *must* take '**(I-1)** & **(V-1)**' to be the fundamental property-law pair in order to vindicate the schematic derivation of a law from a potency in accordance with steps (I) through (V).

This is an unhappy position for the dispositional essentialist. As we've seen, **(I-1)** doesn't adequately characterize *electric charge* and **(V-1)** doesn't adequately characterize Coulomb's law. Coulomb's law is best captured by **(V-∀)**, which may be derived from **(I-∀)**. But if, as Bird suggests, **(I-∀)** is not a fundamental property, Coulomb's law is not a law, according to DE, which maintains that the laws are grounded in *fundamental* properties, *viz*. *potencies*. The same point can be put a different way; the simple fact that Coulomb's law cannot be derived from *electric charge* in accordance with steps (I) through (V) would seem to preclude it from enjoying the status of a law, according to DE. DE thus seems to imply that Coulomb's law is not a law after all.

Regardless of one's opinion on the status of so-called Coulomb's *law*, one should not be too eager to bite the bullet here. The problem arose because of a very general feature of Coulomb's law, namely, the fact that it is a *function* relating various *quantities*. *Any* functional law will similarly fail to be derivable from a

corresponding potency in accordance with steps (I) through (V), as DE would like. Perhaps we could say that Coulomb's law is not really a law because it is eliminable in favour of some more fundamental laws. But since the problem was the quantitative nature of Coulomb's law, the dispositional essentialist could fully dismiss the concern only by claiming that there are *no* functional laws at the fundamental level. And this seems like an implausibly strong empirical prediction for a metaphysic of laws to make.

Vetter diagnoses Bird's reluctance to take the property **(I-∀)** as fundamental as stemming from his adherence to the conditional characterization of dispositional properties, according to which the dispositional essence of a *fundamental* property is characterized by a *single* conditional linking stimulus and manifestation conditions. But as we have seen, this conception of dispositions seems inappropriate for characterizing the dispositional essence of the property *electric charge* for the very general reason that *electric charge* confers on its bearers the disposition to exert a range of manifestations in response to a range of stimuli. In other words, *electric charge* is irreducibly multi-track. The dispositional essentialist thus seems forced either to predict that all potencies will be single track, i.e., characterizable along the lines of **(I-1),** or to give up (DE_P) $\Box(Px \rightarrow D_{(S,\,M)}x)$, i.e., to sever the connection between potencies and conditionals. The former is an implausibly strong empirical prediction whereas that latter is central to the derivation of (V) from (I), and hence to the dispositional essentialist account of laws, its rejection would thus seem to constitute the rejection of DE itself.

2.4 A Cartwrightian Concern

Dispositional essentialism distinguishes lawful regularities from non-lawful regularities on the grounds that the former, but not the latter, are grounded in the dispositional essences of *potencies.* In this section I want to consider the implications for DE of the line of thought, typically associated with Nancy Cartwright (1983), but also discussed by Lange (1993), among others, according to which there are really very few regularities in nature which conform to the grammar of the natural laws.

In section 2, I noted that the falsity of the simple conditional analysis of dispositions, (CA□): $\Box(D_{(S, M)}x \leftrightarrow (Sx \Box\rightarrow Mx))$, required modification of the schematic law statement (V) along the following lines $\forall x((\textit{ceteris paribus } Px \ \& \ Sx) \rightarrow Mx)$. This allowed Bird to claim additional explanatory utility for DE, because the falsity of (CA□) provides an explanation of the *ceteris paribus* nature of laws. The fact that the truth of law statements requires *ceteris paribus* qualification is a datum that an account of laws should be able to explain (my own explanation of this fact comes in chapter 4 and requires some work to build up to). Bird explains the *ceteris paribus* nature of laws by showing that law statements derive from instances of (CA□), which themselves require *ceteris paribus* qualification for their truth. So, the *ceteris paribus* nature of (CA□) is transmitted to the laws that derive from it.

The law of thermal expansion, for example, describes how metals expand with temperature. More precisely, it tells us that when a metal bar of length L_0 undergoes a change in temperature T, the length of the bar changes by $L = kL_0T$, where k is a constant.[7] This law, however, is clearly far from exceptionless. Any number of external factors may conspire to make it the case that, although a bar is heated, it *fails* to change length by $L = kL_0T$. Someone might hammer in the ends of the bar at the same time as it is heated, or it might be heated while contained within a rigid box, which perfectly fits the bar's length and which itself does not change shape when the bar is heated, etc. And in such cases, the bar, though heated, would not *change length by* $L = kL_0T$. The truth of $L = kL_0T$ thus requires a *ceteris paribus* clause to rule out all such circumstances in which a bar is heated and yet fails to expand as the law describes.

Consider again Coulomb's law, $F = \epsilon \frac{Qq}{r^2}$, which (in conjunction with Newton's second law of motion, F=ma) implies that like charges will accelerate away from each other. Without appropriate *ceteris paribus* qualification, however, $F = \epsilon \frac{Qq}{r^2}$ *is* false. For example, a child might decide to push together two negatively charged balloons, *b1* and *b2*, in which case *b1* and *b2* would fail to accelerate away from each other, as Coulomb's law implies. The acceleration of charges implied by

[7] The example in this context is due to Lange (1993).

Coulomb's law can also be hampered at the subatomic level too. Two electrons in complete isolation, for example, might be expected to quite regularly manifest their dispositions to behave in accordance with Coulomb's law, but add to the situation a large mass and the electrons will behave in a way that is not accurately describe by Coulomb's law. In fact, Coulomb's law will not even truly describe a closed system consisting of just two electrons. This is because electrons instantiate *charge* and *mass*; so, electromagnetic and gravitational forces will influence their behaviours. For any given "lawful regularity" it seems that we can multiply examples of cases in which the regularity at hand would fail to obtain. There is a plethora of provisos required for laws such as Coulomb's law and the law of thermal expansion to even come close to being true.

Considerations along these lines have led Cartwright (1983) to argue that the laws of physics *lie*, by which she means that there are exceedingly few generalizations in nature that conform to the grammar of natural laws. To be precise, Cartwright's arguments would seem to establish that there are very few regularities in the course of events, where the course of events is made up of facts about the "actual values of properties such as position, velocity, mass, charge, etc.—the kinds of properties generally acceptable to a Humean" (Corry 2011, 269). It has been suggested, however, that regularities between entities not within the course of events would be consistent with Cartwright's arguments, e.g.(Earman, Roberts, and Smith 2002). Such views are then ontologically committed to entities somehow outside the course of events, whatever they may be. I will not be concerned here with the possibility of regularities between entities that are outside of the course of events. This is because such views introduce additional controversial metaphysical postulates and do not even help the dispositional essentialist to overcome the issue that Corry (2011) argues is posed by the Cartwrightian considerations outlined. Hence, when I talk about regularities, I will mean regularities within the course of events.

I began this section by mentioning Bird's claim that the strict falsity of (CA□) afforded DE additional explanatory utility because it allowed for an explanation of *ceteris paribus* laws. However, the Cartwrightian considerations outlined suggest

that *ceteris paribus* laws are no mere exceptions to be explained, they are ubiquitous. Corry (2011) has argued that the scarcity of regularities which conform exactly to the grammar of natural laws spells trouble for DE. DE purports to show that the instantiation of a potency entails a regularity, that was the point of the derivation in steps (I) through (V) (see sect. 2 above), and that any regularity so derivable counts as a law. But given an abundance of potencies, the deductive steps (I) through (V) would seem to imply an abundance of lawful regularities, which is *contrary* to the Cartwrightian observation. So, for DE to embrace the Cartwrightian position would require, Corry argues, the concession of one of the following:

(1) At least one of (CA□) or (DE_p) is false.
(2) The antecedents of (CA□) and/or (DE_p) are rarely satisfied – which is to say that dispositional properties are rarely instantiated.
(3) The antecedents of (V) are rarely instantiated.

(Corry 2011, 269)

Let's take a moment to get clear on how conceding any one of the claims (1) - (3) would help DE to accommodate the Cartwrightian position. The derivation of a lawful regularity (V) from a claim about the dispositional essence of a potency (I) was crucially dependent on the association between a potency's dispositional essence and a conditional, as expressed in (CA□) and (DE_p). If, in accordance with (1), (CA□) or (DE_p) were false, then there might be an abundance of potencies but very few regularities because the inference from a statement about a potency's essence to a regularity in accordance with steps (I) through (V) crucially depended on the *truth* of (CA□) *and* (DE_p). In other words, conceding (1) would render the inference from a claim about the essence of a potency to a regularity unsound. If, in accordance with (2), dispositions were rarely instantiated, there could be very few lawful regularities, even granting the soundness of the deduction of (V) from (I). Finally, if, in accordance with (3), the antecedents of (V) were rarely realized, which is to say, if it were the case that individuals rarely both instantiated potencies *and*

acquired the appropriate stimuli such as to yield their characteristic manifestations, there might be very few lawful regularities of the type expressed in (V). So, options (1) - (3) each make room, in slightly different ways, for the possibility that there are exceedingly few regularities that conform to the grammar of laws, and hence each seeks to render DE consistent with the Cartwrightian considerations outlined. The question, then, is whether any of (1) - (3) really is compatible with DE. Following Corry (2011), I'll consider these options in turn as ways the dispositional essentialist might accommodate the observation that *ceteris paribus* laws, far from being interesting exceptions, are ubiquitous.

Corry quickly dismisses option (2), the suggestion that essentially dispositional properties are rarely instantiated. This option, he argues, "would spell doom for the dispositional essentialist project, since it would imply that dispositions play little role in the workings of the everyday world" (Corry 2011, 269). And Corry argues that option (3) fares no better because to concede option (3) would be to admit that much of what goes on in the universe is not governed by natural laws. In which case, much of what goes on would be entirely (metaphysically) independent of potencies and their dispositional essences (Corry 2011, 270). For similar reasons, conceding (2) or (3) would be antagonistic to *my* interests in this thesis, which are to account for both laws and modality in terms of dispositional properties and to explore the resultant relations between these phenomena. If there were very few dispositional properties instantiated throughout the world, or if dispositional properties were very rarely manifested, then the idea that *all* facts about laws and modality (of which there would seem to be a great many) and the interactions between laws and modality could be explained in terms of such properties would lack plausibility. Options (2) and (3) both render DE, (or indeed any attempt at a metaphysical explanation of the goings on in the world in terms of dispositional properties) trivial and unexplanatory; they concede the soundness of the dispositional essentialist's derivation of a lawful regularity from the essence of a potency in steps (I) through (V), while maintaining that the conditions for such regularities' obtaining are rarely (if ever) met. Option (1), however, deserves some more detailed consideration.

Option (1) would seem to be the obvious concession for DE to make, after all, and as already mentioned, (CA□) is in fact false. (CA□) is false because of the possibilities of *finks* and *antidotes*, (see Bird 2007, sec. 2.2 and Vetter 2015, sec. 2.2).

An individual *x* is said to be *finkishly* disposed to M if it is such that in the time between its acquiring stimulus S and its manifesting manifestation M, it changes in some way such that the causal basis for the disposition is lost and hence M is not manifested. A live wire, for example, may be finkishly disposed to deliver an electric shock. This would be the case if the wire were such that when it is touched it ceases to be live before the shock can be delivered; perhaps there is some safety mechanism installed in a broader system of which the wire is a part. In such a case, it is true that the live wire has a certain disposition – it is live – but the corresponding counterfactual according to which it would shock a person if they were to touch it, is false.

Antidotes work, not by changing the causal basis of a disposition, but by changing the environmental conditions such that although an individual that is disposed to yield M in response to S acquires S, it fails to yield M. A fragile vase, v, for instance, is disposed to break when dropped. If, however, v were wrapped in bubble wrap and dropped onto a foam mattress, it would not break. Again, it is true that the vase is disposed to break and false that it would break if it were dropped.

More concisely, for any individual, *x*, instantiating disposition, $D_{(S, M)}$, *finks* work by altering the casual basis of D in the time between *x*'s receiving S and yielding M such that *x* receives S but fails to yield M. Antidotes work by creating an environment in which, although *x* instantiates $D_{(S, M)}$, other factors prevent *x* yielding M in response to S. Finks and antidotes thus provide counterexamples to the necessary equivalence between dispositions and the truth of counterfactual conditionals expressed in (CA□).

Now Corry argues that to properly embrace the Cartwrightian position, DE would have to admit that the potencies, which ground laws, are *plagued* by finks and/or antidotes (Corry 2011, 270). For recall that the claim is not that *ceteris paribus* laws are mere exceptions to be accommodated, rather it is that there are exceedingly few regularities in nature of the type described by natural laws.

Let us first consider the idea that finks may be ubiquitous at the fundamental level. In this case, instances of, for example, *charge* may frequently receive their characteristic stimulus: *being in close proximity to distinct charges*. However, more often than not, in the time between an instance of *charge* receiving this stimulus and yielding its manifestation, the causal basis of *charge* is lost and hence no characteristic manifestation is yielded. But this description is perhaps implausible. Bird has argued that there are no finks at the fundamental level. This is because, on the one hand, potencies, that is, *fundamental* essentially dispositional properties, by hypothesis, have no distinct causal basis with which a finkish intervention could interfere. And on the other, while a potency might be lost directly, that is, without interference with a causal base, it seem implausible that, at the fundamental level, a potency could be lost *after* receiving its characteristic stimulus but *before* yielding its manifestation (2007, 60–62).

What about fundamental *antidotes*, then? Even if potencies have no distinct causal base with which a finkish intervention could interact, it does seem possible that factors external to, say, a given instance of *charge*, *e*, could conspire to make it the case that *e* consistently fails to manifest acceleration in response to being in close proximity to other instances of *charge*. Plausibly, something could consistently "get in the way" of a charged body so that it cannot accelerate anywhere. The important point is that the possibility of antidotes at the fundamental level allows for the possibility that there are exceedingly few regularities of the kinds described by laws of physics, if such antidotes are ubiquitous. However, according to Corry, the suggestion that antidotes at the fundamental level are ubiquitous spells trouble for DE.

From the supposition that the manifestation of some potency, *P*, is plagued by antidotes in a wide variety of circumstances, Corry derives an epistemological problem and a metaphysical problem. According to the epistemological problem, we would have no good reason to believe that *P* is instantiated anywhere in the universe, which, in turn implies that *P* should play no role in our formulation of the laws of nature. According to the metaphysical problem, if *P* is consistently hampered and so hardly ever manifest, it cannot be the source of any of the

regularities that we do observe and hence cannot be responsible for any observed law of nature (Corry 2011, 268). From these observations, Corry concludes that

> [I]t is vital for the dispositional essentialist project that fundamental antidotes are not very common. Dispositional essentialism only makes sense if the fundamental laws are strict, not *ceteris paribus*. Thus Cartwright's claim that all laws are *ceteris paribus* laws poses a challenge to the dispositional essentialist. (Corry 2011, 268).

According to DE, potencies ground the laws because it is part of their essence to dispose their bearers to interact in accordance with laws. Furthermore, according to DE, potencies are individuated according to the laws in which they feature. The potency *charge*, for example, essentially disposes its bearers to interact in accordance with Coulomb's law and this distinguishes *charge* from, say, *mass*. But if *all* DE says about *charge* is that it disposes its bearers to interact in accordance with Coulomb's law, then the epistemological and metaphysical problems do indeed rear their heads. If Coulomb's law is hardly ever exemplified, and if all we know about *charge* is that it disposes individuals to interact in accordance with Coulomb's law, then it seems that we lack any reason to believe that *charge* is instantiated. And, on the metaphysical side, if all *charge* does is dispose its instances to interact in accordance with Coulomb's law, and if Coulomb's law is rarely, if ever, exemplified, then it would seem that *charge* has little to nothing to do with what goes on in the universe. In short, if potencies can bear metaphysical responsibility only for behaviours that conform to the grammar of natural laws, then the ubiquity of *ceteris paribus* laws poses a problem for DE's explanatory aims.

The obvious response to these concerns is to maintain that potencies can bear metaphysical responsibility for behaviours that *do not* conform to the grammar of laws. So, while *charge*, for example, might, under very specific circumstances, produce behaviour that conforms to the grammar of Coulomb's law – under tightly controlled lab conditions, say – *charge* can also act in other circumstances to produce behaviours that do not strictly conform to the grammar of Coulomb's law. The idea,

then, is that potencies are *multi-track* because they dispose their bearers to behave in a variety of ways depending on the details of the situation. If potencies are understood as multi-track in this way, it is no objection to the claim that potencies bear metaphysical responsibility for what goes on in the universe to note that, strictly speaking, laws, such as Coulomb's law, are very rarely exemplified.

Corry discusses this response but argues that this way of understanding potencies, as diversely multi-track, raises a new epistemological problem. Plausibly, if, say, *charge*, ever produces behaviour that *does* conform to the grammar of Coulomb's law, it will be under the tightly controlled conditions of the lab. But if outside the lab, *charge* is responsible for all sorts of behaviours that don't conform to the grammar of Coulomb's law, then it seems that our practice of applying what we learn in the lab to real world situations lacks justification; we have "no justification for using our knowledge of how the disposition works in one situation to make predictions in another" (Corry 2011, 272). So, while perhaps among the many tracks of *charge* is a disposition to behave in accordance with Coulomb's law, and this is what is exposed under lab conditions, it is nonetheless a mystery why we should apply this particular fact to predict how *charges* will behave outside the lab. The ubiquity of *ceteris paribus* laws thus threatens to undermine either DE's ability to metaphysically explain what goes on in the universe or DE's ability to explain our practice of applying what goes on in the lab to real-world settings.

This section highlights the difficulty faced by DE in making sense of the multifarious *interactions* between potencies. The Cartwrightian considerations of this section suggest that, for the most part, the universe evolves in accordance with many, many different potencies all interacting with each other. The result of this is that very little of what goes on in the universe conforms to the grammar of the laws of physics. DE, however, says nothing about the various interactions between potencies. Rather, it seeks to explain the temporal evolution of the universe by appeal to the contributions made by *particular* potency instances considered in isolation from each other. But since the contributions made by, say, *charge* and *mass* are often thoroughly mixed up in a causal nexus of many different potencies all interacting with each other, DE lacks a story about precisely how these potencies

contribute. All that DE offers by way of characterization of, say, *charge*, is the *law*, Coulomb's law, which individuates *charge*. Thus, when the contribution made by *charge* to the causal nexus of potencies that determines the evolution of the universe does not conform to the grammar of Coulomb's law, DE is at a loss to explain what goes on in terms of *charge*. The account of laws that I present in chapter 4, by contrast, is built around the idea that the universe temporally evolves in accordance with the many and varied interactions between all potency instances considered collectively.

2.5 Tying the Problems Together

In section 2.2, I presented Bird's (2007) dispositional essentialist account of natural law, which consists in deriving a universal generalization from a statement about the essence of a potency in accordance with steps (I) through (V). However, it seems that for the dispositional essentialist strategy of accounting for the laws in terms of potencies to work in any *particular* case of a law, *L*, and potency, *P*, whereby *P* grounds *L*, *L* must *constitute* the essence of *P* so that the characterizing statement of *P*'s essence allows for the logical deduction of a statement of *L*. But this explanation of *L* in terms of *P* doesn't seem particularly satisfying if we must first build *L* into the essence of *P* – the "explanation" now has a whiff of circularity (at the very least).

Jaag (2014) offers a formal presentation of the above concern. He points out that, according to DE, natural modalities (be they laws, counterfactuals, dispositions or whatever) pertain to the essences of potencies, because they constitute those essences. But potencies are then supposed to ground those very natural modalities that are constitutive of their essences. However, Jaag argues that, given some plausible assumptions about essential dependence, metaphysical priority and grounding, nothing can ground that which pertains to its own essence, hence a potency, *P*, cannot ground a law, *L*, if *L* pertains to the essence of *P*. The details of Jaag's argument can be left aside for present purposes, for now it suffices to note that Jaag's arguments constitute a formalization of the intuition that it is not particularly satisfying to build a law, *L*, into the essence of a potency, *P*, only to then claim that *P* metaphysically explains, or *grounds*, *L*.

In section 3.5, I present my own more formal account of this concern, which shows that, according to DE, properties and laws symmetrically ground each other, which means that the former cannot be invoked in a non-circular metaphysical explanation of the latter. For the rest of this section, I'll be concerned just with showing that the previous two concerns of this chapter, Vetter's concern about functional laws and Corry's Cartwrightian concern, seem to be closely related to this suspicious feature of DE according to which potency essences are constituted by the very laws that they are supposed to ground.

Recall the issue raised by Vetter (2012), and discussed in section 2, was that functional laws, such as Coulomb's law, which relate quantities, cannot be derived from the essence of a potency in accordance with steps (I) through (V) (see Bird 2007, 46, or section 2.2 above for the derivation that is at the core of DE's account of laws). The implication was that there are no functional laws at the fundamental level, which is an implausibly strong empirical constraint for a metaphysic of laws to impose.

The first step of the dispositional essentialist's derivation of a law, *L*, from a claim about the essence of a potency, *P*, involves characterizing the essence of *P* with a counterfactual conditional:

(I) $\Box(Px \rightarrow (Sx \ \Box\!\!\rightarrow Mx))$

However, there is no characterization of *P*'s essence in terms of a *single* counterfactual conditional, which allows for a derivation of anything like Coulomb's law (or any other functional law for that matter). This was the nub of Vetter's argument. We *can*, however, offer the following characterization of the essence of potency *charge e*:

(I-∀) $\Box$(x has charge e $\rightarrow$ **∀**charges q_i **∀**distances r_i (x is at distance r_i from q_i $\Box\!\!\rightarrow$ x exerts a force $F_i = \epsilon \frac{eq_i}{r^2}$)

From which we may derive:

(V-∀) $\forall x \forall r_i \forall q_i$ ((x has a charge e & x is at a distance r_i from charge q_i) → x exerts a force of $F_i = \epsilon \frac{eq_i}{r^2}$)

Where **(I-∀)** is a plausible characterization of the essence of *electric charge* and **(V-∀)** seems pretty close to Coulomb's law. But **(I-∀)** is not an instance of (I) and **(V-∀)** is not an instance of (V), so any derivation of the latter from the former does not count as a *dispositional essentialist* account of natural law, in Bird's sense.

The problem that Vetter raises comes about for two reasons: i) potency essences must be characterizable in terms of a single conditional and ii) for any potency, *P*, and law, *L*, such that (according to DE) *L* is grounded in *P*, the essence of *P* must be constituted by *L*, such that a characterizing *statement* of the essence of *P* permits a logical derivation of a statement of *L*. But, Coulomb's law, for example, cannot be *built in* to the essence of *P* in such a way that a statement characterizing *P*'s essence permits a logical derivation of a statement of Coulomb's law in accordance with DE's steps (I) – (V). The problem arises because DE must, on the one hand, build laws into essences, but on the other, it is restricted to characterizing those essences in terms of counterfactuals. What Vetter has shown is that these two requirements are in tension in the case of functional laws.

Vetter diagnoses the problem primarily in terms of the requirement that the dispositional essence of a potency be characterizable in terms of a single conditional. She suggests that the difficulty of deriving Coulomb's law from the essence of *electric charge* in accordance with DE's steps (I) – (V) is a symptom of the fact that *electric charge*, among other potencies, is irreducibly multi-track and hence not characterizable in terms of the counterfactual, which connects a *single* stimulus with a *single* manifestation. What I have sought to add is that the independently suspicious feature of DE, according to which potency essences must comprise the very laws that they supposedly ground, also plays a role in generating Vetter's problem about functional laws.

Vetter advocates an alternative, *possibility conception* of dispositions, according to which:

1. A disposition is individuated by its manifestation alone: it is a disposition to M, full stop
2. Its modal nature is that of possibility, linked to or best characterized (to a first approximation) by '*x* can M'.

(Vetter 2015, 65)

Elsewhere, Vetter argues that dispositionality is a matter of degree and that what is distinctive of the nomological dispositions is that they are possessed to the (near) maximal degree (Vetter 2015, chap. 3). This means that the disposition associated with the potency *electric charge* is not merely such that some individual, *x*, that instantiates *electric charge* can yield characteristic manifestation M, rather, in some qualified sense that needn't concern us for present purposes, if *x* instantiates *electric charge*, then it is *necessary* that *x* M's. What do we substitute M for in the case of *electric charge*? Vetter's suggestion is, roughly, that if *x* instantiates *electric charge*, then *necessarily x* exerts "a force *F* whose value stands to the surrounding charges *q* and their distance *r* in the precise mathematical relation $F = \epsilon \frac{eq}{r^2}$" (Vetter 2015, 285). That is to say, if *x* instantiates *electric charge*, then *necessarily x* exerts a force in accordance with Coulomb's law. Hence, Vetter replaces Bird's characterization of the potency P

(I) $\Box(Px \rightarrow (Sx \ \Box\!\!\rightarrow Mx))$

With

(I*) $\Box(Px \rightarrow \Box Mx)$

Where *built in to* M is whatever law is associated with *P*. What I have argued, however, is that insofar as we are interested in metaphysically explaining the laws of nature in terms of potencies, we should be reluctant to build those very laws to be explained into the essences of the potencies that are supposed to do the explaining. More work needs to be done, then, on the metaphysics of laws and properties such that we may properly explain the former in terms of the latter; this work I do in chapters 3 and 4.

In section 3, I discussed how Cartwright's observation that the laws of nature *lie* risks placing much of what goes on in the universe, as well as our scientific practice of applying what we learn in the lab to real-world situations, beyond the explanatory purview of DE. Again, I want to suggest that the feature of DE according to which laws constitute the essences of potencies causes the problems here. Recall, Corry (2011) argues that in order to accommodate the Cartwrightian observation that there are exceedingly few regularities in the unfolding of events in the universe of the kind described by laws of nature, it must be conceded that *antidotes* are pervasive. The argument proceeded along the following lines.

1. Potencies are ubiquitous and essentially such that they dispose their bearers to interact in accordance with laws of nature (DE's essentialist core claim).
2. There are exceedingly few regularities of the type described by natural laws (Cartwright's arguments).
3. To accommodate 1 and 2, it must be conceded that antidotes consistently hamper the dispositions to behave in accordance with laws that are characteristic of the essences of potencies.
4. But if the dispositions conferred by potencies are consistently hampered, then much of what goes on in the universe must not be explicable in terms of the dispositional essences of potencies – *contra* DE's explanatory aims.

The dispositional essentialist could maintain, however, that the dispositional essences of potencies dispose individuals instantiating those potencies to do more

besides behaving in a manner that conforms to the grammar of natural laws. So, while the presence of antidotes might hamper an instance of *charge's* disposition to behave in accordance with Coulomb's law, that same antidote might be thought of as *facilitating* that instance of *charge's* behaving in other ways that *also* metaphysically depend on the essential nature of *charge.* In other words, charge, and other potencies, might dispose their bearers to behave in a variety of ways depending on which other potencies are instantiated nearby, where very few of these behaviours conform to the grammar of laws.

Point 4 only follows if it is held that natural laws *exhaustively* constitute the dispositional essences of potencies such that potencies *only* dispose their bearers to behave in accordance with laws. 1 - 3 above would be consistent with the *denial* of 4 if it were admitted that potencies dispose their bearers towards a whole range of behaviours including behaviours not described by any specific law. Corry explores the possibility that the essences of potencies dispose their bearers to do *more* than just behave in accordance with particular laws, and hence that potencies are *multi-track*. The "tracks" must then be as diverse as the range of behaviours we want to explain in terms of potencies. The concern with this suggestion, however, is that if potencies dispose their bearers to such a variety of behaviours it is not clear how we can be justified in applying what we know about potencies in one scenario, the lab, to other scenarios in the real-world (Corry 2011, 272).

The problems here seem to stem from the crude (and as I have suggested, unexplanatory) model of the relationship between potencies and laws whereby the latter are constitutive of the essences of the former. On this model, either laws *exhaust* the dispositional essences of potencies, or they *partly* constitute the dispositional essences of potencies. If we think laws *exhaust* the dispositional essences of potencies, and in the absence of a theory about potency interactions, potencies cannot explain much of the goings on in the universe that do not conform to the grammar of the laws. If, on the other hand, we think that laws partly constitute the essences of potencies, along with dispositions for other behaviours too, then we lack an explanation for applying what we discover about the *lawful component* of a potency's essence to scenarios outside of the lab setting in which it

was discovered. Either way, the position is not a comfortable one for the dispositional essentialist.

My suggestion, then, is that if we do away with DE's crude model of the relationship between laws and potencies whereby the former "contain" the latter, the present problems will dissolve. In chapters 3 and 4 I motivate and defend a metaphysic of properties and an account of laws in terms of those properties, which is well placed to overcome the issues raised here.

3. QUALITATIVE DISPOSITIONAL ESSENTIALISM

3.1 Introduction

In chapter 1, I presented some reasons for denying quidditism and maintaining instead that there are necessary connections between fundamental properties and the dispositions/behaviours (I use these terms interchangeably) with which they are associated. I opted to call the collection of dispositions with which a given property, P, is associated P's *modal profile* (though in section 4.5 I will introduce and work with a more precise definition of this term). Hence, the suggestion is that there exist necessary connections between fundamental properties and their modal profiles.

It was noted in chapter 1 that this anti-quidditist picture perhaps has some theoretical advantages, including the potential to avoid certain sceptical results for quidditism and the fact that it paves the way for an attractive metaphysics of modality namely *hardcore actualism* (HA). What remains unexplained, however, is how the necessary connections between properties and their modal profiles arise. The previous chapter touched on the dispositional essentialist explanation of these necessary connections according to which properties and dispositions are necessarily connected because the essences of properties are *constituted* by dispositions. It was noted that the dispositions that constitute the essences of properties, according to DE, are dispositions to behave in accordance with laws. Hence, DE simultaneously builds laws into the essences of properties and purports to explain those laws in terms of those property essences. This, it was argued, is intuitively unsatisfying and also connected to two more specific problems – Vetter's problem of functional laws and Corry's Cartwrightian concern.

In this chapter, I look in more detail at the specific metaphysics of properties associated with dispositional essentialism, where I use "dispositional essentialism", or "DE", to refer to a package deal comprising a metaphysic of properties and an account of the laws of nature in terms of those properties. Not merely is it the case,

according to DE, that *some* property essences are *partially* constituted by dispositions, or that some property essences are *exhaustively* constituted by dispositions or that all property essences are *partially* constituted by dispositions. Rather, DE holds that *all* property essences are *exhaustively* constituted by dispositions. What this view entails is that properties have their identities fixed by their place in a structure of relations among properties. Hence, I shall use the term "structuralism" to refer to this particular metaphysic of properties according to which all property essences are exhaustively constituted by dispositions – "dispositional essentialism" or "DE" will be reserved to refer to the package of a structuralist metaphysics of properties and the identification of laws with arcs in this structure (details in section 3.5).

Various proponents of structuralism purport to explain the space-time distribution of property instances in terms of those properties' dispositional essences. In this chapter, I present a problem for structuralism's explanatory aims in this respect, due to Barker and Smart (2012), which is independent of any specific concern with accounting for laws of nature. I add to this concern a further worry according to which the dispositional essentialist account of laws as arcs in the structure is unsatisfactory because it implies that properties and laws symmetrically ground each other and, hence, that DE cannot provide a non-circular metaphysical explanation of laws in terms of properties. This symmetrical grounding worry constitutes a more precise articulation of the idea that DE's strategy of building laws into the essences of properties which are then used to account for those very laws is unexplanatory.

Tugby's (2012) response to the problem for structuralism that Barker and Smart raise is to give up structuralism in favour of the view according to which properties have *qualitative* essences, which nonetheless *ground* dispositions – call this view *qualitative dispositional essentialism* (QDE). QDE thus constitutes an alternative explanation of the necessary connection between properties and their modal profiles, one which does not simply build dispositions into property essences. I argue that QDE is superior to structuralism in two other (related) respects: it is not committed to symmetrical grounding and it is committed to fewer

ontologically basic entities than structuralism. Finally, I attempt to soften a concern according to which the claim that qualities ground dispositions is opaque. The aim of this chapter, then, is to crystalize concerns with the dispositional essentialist package deal and to motivate my positive view of the metaphysics of properties.

3.2 Essentially Dispositional Properties

In this section, I'll discuss Vetter's alternative conception of dispositions according to which dispositions are individuated via their manifestations alone and allied with possibility. Vetter's view is motivated by a strong argument against the standard conception of dispositions understood in terms of conditionals linking stimulus and manifestation conditions. Furthermore, it simplifies the ensuing comparison of the structuralist and qualitative dispositional essentialist understandings of the relationship between property essences and dispositions if dispositions are understood just in terms of their manifestations.

3.2.1 Vetter's Conception of Dispositions

According to the standard conception, dispositions are understood in terms of their characteristic stimulus (S) and manifestation (M) conditions, linked by a counterfactual conditional. To say that an individual, x, has a disposition, D, to yield M in response to S is to say that *if x were* to receive stimulus S, *then x would* yield manifestation M (e.g., Lewis 1997; Bird 2007). The standard conception of dispositions was discussed in section 2.2.

Vetter (2015, chaps 2–3) has forcefully argued against individuating dispositions via some stimulus-manifestation pair and, hence, against allying dispositions with conditionals. In a nutshell, Vetter's concern is that all but the most contrived dispositions will be associated with infinitely many stimulus-manifestation pairs and, hence, with infinitely many conditionals linking each particular stimulus-manifestation pair. A disposition to shatter, for example, is really a disposition to shatter into many or fewer pieces if dropped from a greater or lesser height; x's being disposed to shatter will imply that x will break into n pieces if dropped from height h, n' pieces if dropped from height h' and so on. A

disposition (of an instance of positive charge) to exert a repulsive force on other positive charges is really a disposition to exert a greater or lesser force depending on the magnitude of the other charge and the distance of separation between the two charges. As Vetter puts it, the stimulus and manifestation conditions of all but the most contrived of dispositions exhibit great qualitative and quantitative diversity (Vetter 2015, chap. 2). To avoid characterizing dispositions in terms of infinitely many conditionals, Vetter recommends that dispositions are individuated via their manifestation conditions alone, which allows for them to be characterized in terms of a single possibility statement, which can take scope over a (potentially infinite) disjunction of manifestations (e.g., Vetter 2015, 60). According to Vetter's conception of dispositions:

1. A disposition is individuated by its manifestation alone: it is a disposition to M, full stop.
2. Its modal nature is that of possibility, linked to or best characterized (to a first approximation) by 'x can M'.

(Vetter 2015, 65).

We can thus begin to flesh out the claim that, e.g., *fragility* is an essentially dispositional *property* in accordance with Vetter's conception of dispositions by saying that *fragility* is individuated by a characteristic manifestation, *shattering* (perhaps among others), that its bearers *can* yield. In all possible worlds, for an individual, x, to instantiate *fragility* is for it to be the case that x *can* shatter.

But possibility would seem to be too weak to characterize *fundamental* dispositional properties, such as positive charge. It is more appropriate to say that if x is positively charged, then x *must* (perhaps in some restricted sense) accelerate towards instances of negative charge. That is to say, fundamental properties, such as electric charge, seem more closely allied with necessity than with possibility.

For Vetter, *potentiality* is the basic, context insensitive backdrop for the context sensitive notion of dispositionality, where for x to have a potentiality to M,

is for it to be the case that x *can* M. All dispositional properties are potentialities, though not all potentialities are dispositional properties. Potentialities can be possessed to greater or lesser degrees; both a brick and a vase have a potentiality to break – both *can* break – but the vase possesses this potentiality to a greater degree.

In order for an individual, x, to count as being disposed towards some manifestation, M, x must possess the potentiality for M to a sufficiently high degree, where what counts as "sufficiently high" will be determined by context. So, the vase is disposed to break (it is *fragile* for short) whereas the brick is not because the vase but not the brick possesses the potentiality to break to a sufficiently high degree to count as being disposed to break (in most contexts, anyway; the brick may count as being disposed to break in, say, the context of preparing the foundations for a skyscraper). In other words, we might say that (in most contexts) the vase's potentiality to break is a dispositional property, whereas the brick's potentiality to break is not.

If a potentiality for M is possessed by x to the *maximal* degree, then x has no potentiality not to M, which is to say that *necessarily* x is M. As a potentiality is possessed to a higher and higher degree, the modality with which it is associated is closer and closer to necessity. Fundamental potentialities, such as positive charge, may then be understood as only being able to be possessed to a particularly high degree, and hence closer to the *necessity* end of the potentiality scale (Vetter 2015, 84–95).

Since my main concern here is not with how best to understand dispositions *per se*, I must omit a more thorough discussion of Vetter's view. I will, however, often follow Vetter in talking in terms of the broader notion of *potentiality*, instead of dispositionality, where to be disposed to M is to have a potentiality for M to a sufficiently high degree. Furthermore, I will assume Vetter's understanding of potentialities/dispositions (where nothing is at stake, I will not discriminate between potentialities and dispositions) in terms of the possibility of their manifestations. I do this for two reasons: for one, I find Vetter's case against the standard conception of potentialities/dispositions in terms of a counterfactual linking stimulus and manifestation conditions convincing and for another, it will

simplify the following discussion to talk just in terms of manifestation conditions of dispositions as opposed to stimulus *and* manifestation conditions. However, nothing of substance in this chapter hinges on this choice. The critiques of structuralism and dispositional essentialism that I present would be unchanged if the dispositions constitutive of the structuralist's property essences were understood in accordance with the standard conception.

3.2.2 Structuralism and QDE

Regardless of whether one understands dispositions in terms of a stimulus-manifestation pair linked by the counterfactual, or in terms of the possibility of the manifestation alone, a distinct disagreement concerns how, precisely, to understand the relationship between the essences of properties and the dispositions that those properties confer upon their bearers.

On the one hand, *structuralists* (e.g., Chakravartty 2003a; Mumford 2004; Bird 2007; Mumford and Anjum 2011) maintain that *all* properties are essentially and *exhaustively* relational: "the [structuralist] wants the essences and hence identities of her entities to be determined *relationally* rather than purely intrinsically"[8] (Bird 2007, 139); a property is "nothing more than a set of connections to, and causal powers for, other properties" (Mumford 2004, 185).

Consider, for illustrative purposes, the properties *fragility* and *shattering*.[9] The property *fragility* disposes its bearers to manifest *shattering* – thus (sticking with Vetter's conception of dispositions) if x is *fragile* then x *can* shatter. Let us say, then, that *fragility* and *shattering* stand in the *manifestation relation* (M-relation for short).[10] Now to say that *fragility* is essentially and exhaustively relational, is to say that the essence of the property *fragility* is exhausted by the M-relations in which it stands to other properties. M-relations are internal to properties, according to the

[8] Bird calls his structuralist view of properties *dispositional monism*.
[9] Since *fragility* is likely not a fundamental property, it would probably not be within the remit of Bird's structuralism; Bird limits his attention to *fundamental* physical properties. Mumford, however, does not limit his attention to fundamental properties.
[10] If I were working with the standard conception of dispositions, I might talk about the *three* properties *being dropped, fragility* and *shattering* standing in the stimulus-response relation (SR-relation) (see, e.g., Barker and Smart 2012). But nothing of significance hinges on this choice. In what follows "M-relations" could be everywhere substituted for "SR-relations" without altering the argument.

structuralist, and *all* natural properties have their essences, and hence identities, exhausted by the M-relations in which they stand to other properties. Properties and the M-relations that they enter into, make up a vast network, or structure. Any given property, P, is then metaphysically (as opposed to cognitively or epistemically) individuated by its position in the structure of relations among properties – what it is to be P is to occupy such and such a place in the structure. Structuralism implies the negation of R-quidditism – properties are not free to recombine with different dispositions, or M-relations, because dispositions constitute their *essences*. Hence, there exist necessary connections between properties and dispositions, according to the structuralist.

An alternative account of the necessary connections between properties and dispositions maintains that properties are *qualities*. The essences of qualities are not constituted by M-relations, nor are qualities merely trivially self-identical and distinct from other properties. Qualities, rather than having their essences constituted by dispositions, ground dispositions and qualitative differences between properties account for differences in which dispositions they ground (see, e.g., Jacobs 2011; Tugby 2012). More recently, Smith (2016) has articulated the position that she calls *non-recombinatorial quidditism*, which, despite the name, would seem to have affinities with this view since it maintains that qualities ground, and hence are necessarily connected to, nomological roles (2016, 250). To say that a property has a qualitative essence is to say that its essence can be given in wholly non-dispositional terms – *geometric* properties are often cited as paradigm qualitative properties because they can be specified non-dispositionally in terms of the mathematical formulae that they satisfy. Call this view, according to which qualities ground dispositions, *qualitative dispositional essentialism* (QDE) (see Tugby 2012). Since, according to QDE, the essences of properties are not constituted by dispositions, *viz*., by their manifestation relations (M-relations) to other properties, QDE does not individuate properties solely on the basis of their place in a structure of relations among properties. Rather, qualities are self-individuating; properties may be thought of as grounding a relational structure, according to QDE, but property essences are not exhausted by their place in that structure.

In light of recent work by Taylor (2017), QDE should be distinguished from the *powerful qualities* view of Martin and Heil (Martin and Heil 1999; Heil 2003; Martin 2007). According to Martin and Heil, properties are dispositional *and* qualitative. On the face of it, then, the Martin-Heil view would appear to be in the QDE camp. However, Martin and Heil are clear that the dispositionality and the qualitativity of a property are *identical*: "Our suggestion is that dispositionality and qualitativity are to be identified" (Martin and Heil 1999, 47). It is generally agreed that identity isn't a grounding relation. In support of this, one may cite the fact that identity is reflexive, but grounding is not. Thus, if the dispositionality and qualitativity of property are identical, the latter cannot ground the former, as per QDE.

But regardless of how we ought to interpret the identity view of Martin and Heil, the important distinction for present purposes is just that between *structuralism* and *qualitative dispositional essentialism* (QDE). That is, between a view of properties as exhaustively constituted by dispositions vs. a view of the essences of properties as qualitative grounds of dispositions.

3.3 A Regress for Structuralism

One of the motivations for structuralism is to provide an explanation of various facts about fundamental property instantiations at space-time regions in terms of the very essences of the properties themselves. For example:

> Modal properties are the grounds of the world's necessity and contingency, and therefore *of the world's patterns and order*. (Mumford 2004, 161, my emphasis)

> [I]f the essence of the property of being negatively charged is a disposition to attract positively charged objects, then all negatively charged objects will attract positively charged objects. (Bird 2007, 3).

And again, in Barker and Smart's words, according to dispositional essentialism (which we can understand as the package of structuralism about properties and the

account of laws sketched in section 2.2),

> [I]t is part of the essential nature of properties that they constrain how they are distributed in instantiation across the space-time continuum. (Barker and Smart 2012, 717)

This is all well and good, but one is entitled to press the question: how, *exactly*, are we to understand the explanatory claim that the distribution of properties throughout space-time is *constrained* by the very natures of those properties? In what follows in this section, I present Barker and Smart's "ultimate argument" (2012) against structuralism, modified to fit my understanding of dispositions along Vetterian lines and, hence, my understanding of the essence of properties in terms of M-relations.

According to the structuralist, there is nothing more to the essence of a property than the M-relations in which it stands to other properties because all properties have their essences exhausted by M-relations. Hence, all that the structuralist may appeal to in answering the question about how properties, F and G, say, constrain how they are distributed across the space-time continuum are the M-relations in which F and G stand to other properties (Tugby 2012, 725, highlights this nicely). To clarify the point, it will help to introduce some abbreviations:

> M(F, G) = the fact that the M-relation holds between F and G

> R = the fact that if x is F then x is disposed to manifest G

Where x's being *disposed* to manifest G implies that *possibly* x is G. But keep in mind that where F is a *fundamental* property, the possibility associated with the disposition to manifest G will be a very "strong" possibility, perhaps closer to a restricted form of necessity, because fundamental dispositional properties, or potentialities, can only be possessed to a very high degree. In which case, R would imply that if x is F then x *must*, perhaps in some restricted sense, manifest G.

We can thus understand the structuralist as positing a necessary connection between M(F, G) and R to explain the spatiotemporal distribution of instances of F and G. It is no *accident*, according to the structuralist, that if M(F, G) holds then R holds, hence it is no accident that if M(F, G) holds then every x that is F will tend to be G. Thus, the spatiotemporal distribution of property instances is explained by M(F, G)'s holding.

But now we may ask: what accounts for the necessary connection between M(F, G) and R? Why is it that in every possible world in which M(F, G) holds, every x that is F will tend to be G? Perhaps there is some *third*-order relation, M*, between the relational facts M(F, G) and R, which ensures that if M(F, G) holds then R holds too. We can denote the situation like this: M*[M(F, G), R]. But now we may ask what accounts for the connection between M*[M(F, G), R], M(F, G) and R? What ensures that if M*[M(F, G), R] holds at a world, w, then if M(F, G) holds R holds too? Is there some *fourth*-order relational fact, M**, such that M**[M*[M(F, G), R], M(F, G), R]? We are clearly off on a regress of higher and higher order M-relations. This is the nub of Barker and Smart's "ultimate argument against dispositional monist accounts of laws" (2012), see also Barker (2013).[11]

The regress just sketched is very closely analogous to what Bird calls "the ultimate argument" against Armstrong's account of properties and laws (Bird 2005). According to Armstrong, fundamental properties are quiddities and hence impose no restrictions on their possible space-time distributions. The spatiotemporal distribution of quiddities is explained in terms of second order necessitation relations, *Ns*, holding between those properties (e.g., Armstrong 1997). Thus, according to Armstrong, a law such as *all Fs are Gs*, is analysed in terms of a second order necessitation relation, N, which holds between the first order (quiddistic) properties F and G. We can denote the situation like this: N(F, G). That is to say, the fact that N(F, G) is what makes it the case that it is a law that all F's are G's and hence *explains* the spatiotemporal distributions of Fs and Gs. N might have failed to hold between F and G – the laws are contingent on Armstrong's view – but in all

[11] The regress is modified slightly to fit my set up in terms of M-relations. Barker and Smart stick with the standard conception of dispositions in terms of stimulus and manifestation conditions, which they call SR-relations. Hence the regress they articulate is of higher and higher order SR-relations.

worlds in which N(F, G) holds, anything that is F is G too. N's holding between F and G is what it means to say that it is a *law* that all Fs are Gs.

The question that Bird poses for Armstrong is this: what makes it the case that if N(F, G) holds, then all Fs are Gs? Since, according to Armstrong, all properties are quiddities, it can be no part of the *essence* of N that whenever N(F, G) holds it is also the case that all Fs are Gs. Thus, according to Bird, Armstrong is impelled to say that there is some *third* order relation, N*, which holds between the first-order relational facts N(F, G) and *every F is a G* and which ensures that if N(F, G) holds then all F's are Gs. But what explains that if N* holds and N(F, G) holds, then all Fs are Gs? Some fourth order relation, N**? Regress beckons, and in much the same way as it does for the structuralist. In both cases, second order relations between first order properties are posited to explain the spatiotemporal distributions of the first order properties. In both cases we may ask what accounts for the relation between the relational fact and the fact about which properties tend to be instantiated together, which pushes us to posit yet higher order relations to meet the explanatory challenge.

Perhaps Bird and Armstrong can block their respective regresses by repudiating the initial explanatory demand. In Armstrong's case, this would amount to the claim that it is just a brute fact that if the second order N relation holds between the first order properties F and G: N(F, G), then all Fs are Gs. If this fact is brute, there is no need to appeal to a third order N* relation and so on and, hence, the regress does not get going. Similarly, the structuralist might say that there is a brute necessary connection between the fact that the M-relation holds between F and G and the fact that for all x, if x is F then x is disposed to manifest G. That is to say, there is a brute necessary connection between M(F, G) and R such that in any world in which M(F, G) holds, R holds too. By maintaining that the necessary connection between M(F, G) and R is just brute, the structuralist needn't appeal to higher order relations and the regress is blocked.

However, appeal to brute necessary connections may seem antagonistic to the motivation for structuralism, which was to explain patterns of property distributions, not in terms of some brute necessary connections, but in terms of the

powerful essences of properties. As Tugby puts it, "One of the main intuitions behind dispositionalism is that the properties of things are not inert: they pack a powerful punch; they give a causal 'biff' to their possessors." (2012, 726). But if it turns out that all the work is being done by brute necessary connections between higher-order relational facts and facts about property instantiations, then this motivation for structuralism seems not to have been satisfied. On the other hand, Bird's structuralism was in no small part motivated by a desire to move away from the Armstrongian view and the problems that it faced. What the above considerations show, however, is that Bird and Armstrong are in the exact same boat: they must either posit brute necessary connections or embrace regress (see Barker and Smart 2012, 721).

The fact that, according to the structuralist, higher-order M-relations between properties *constitute* the essences of those properties is of no help here. As Barker and Smart highlight (2012, 720), the M-relations play two roles: i) a governing role – M(F, G) makes it the case that if x is F, then x is disposed to manifest G – and ii) a constitutive role – M's holding between F and G enters into the constitution of these properties. The identities of F and G are fixed by their entering into the M-relation (perhaps among other relations to other properties). But the fact that M plays a constitutive role is irrelevant to the problem at hand. All that is relevant is that M plays the *governing* role. The governing role is what gets the regress going because, whether M constitutes the essences of F and G or not, we can still ask how it is that M does the governing work that it does. Positing a yet higher order relation sets us on the road to regress, so instead we might say that this fact about M is brute. That is, we might say that M just brutely necessitates that if x is F then x will be disposed to yield G. We could say this, but to do so would be to give up on the structuralist's explanatory aim, which was to explain such necessities in terms of the very natures of the properties involved, as opposed to just fixing them as brute necessary connections.

3.4 Tugby's Proposal

According to the diagnosis offered by Tugby (2012, 725), at the heart of the regress outlined above is the fact that the structuralist's properties exhibit no qualitative differences that could account for the different behaviours that those properties confer. For the structuralist, all differences in conferred behaviours must be accounted for in terms of differences in *relations* between properties, that is, in terms of higher-order M-relations between properties, because the essences of properties are exhausted by the M-relations in which they stand to other properties. Thus, Tugby proposes that "properties *do* have a qualitative nature, which is such as to essentially confer certain dispositions upon their possessors"(2012, 727). This is what Tugby calls *qualitative dispositional essentialism* (QDE). QDE makes available qualitative, that is non-relational, non-trivial, differences between properties to account for the differences in behaviours conferred by different properties. Hence, QDE can avoid appeal to M-relations between properties to account for behavioural differences and avoid the regress that this strategy ushers.

According to QDE, properties differ qualitatively, which is to say they differ *not merely* with respect to the relations in which they stand to other properties. It is the qualitative differences between properties that account for the different dispositions that they confer upon their bearers. Once qualitative differences are introduced, there is no need to appeal to higher-order relations between properties to account for the different behaviours conferred by different properties – all the explanatory work can be done by the qualities themselves. While the essences of qualities are to be understood non-relationally, it is not obvious whether qualities are best understood as wholly non-modal. Perhaps we can understand a quality as non-modal in the same sense in which, say, the property of *being human* is non-modal, or the property of *being spherical* is non-modal; each of these properties can be specified independently of any dispositions or other modal notions. However, the claim, central to QDE, is that qualities (which you can call non-modal, in the previous sense, if you wish) ground relations between themselves and other qualities – this is the dispositional aspect of qualities. And, furthermore, a given quality, Q, could not possibly fail to ground the dispositions that it does, because its

qualitative nature is essential to it – a property instance would not be an instance of Q if it did not have Q's very nature and it is Q's qualitative nature which grounds the dispositions that Q confers upon its bearers (see Tugby 2012, 728).

To give a further sense of the flavour of QDE, Tugby draws attention to the typical association between dispositions and counterfactual conditionals. E.g., x's being *fragile* implies, roughly, according to, e.g., Lewis and Bird, that if x *were* dropped x *would shatter.* We might thus understand the idea that qualities ground dispositions in terms of those qualities being *truthmakers* for certain counterfactual conditionals. According to Tugby: "a thing's property instantiations entirely constitute the *truthmakers* for certain counterfactuals true of that thing." (Tugby 2012, 728, my emphasis). Since truthmaking is plausibly a grounding relation (e.g., Correia 2005; Schnieder 2006), I'll talk in terms of qualities *grounding* the truth of modal propositions.[12] Qualities, according to Tugby, confer certain dispositions upon their bearers because they ground counterfactual conditionals. Thus, if x is positively charged, the quality, positive charge, grounds a counterfactual along the following lines: if x were in close proximity to an instance of negative charge, y, then x would accelerate towards y. Tugby puts the idea schematically as follows:

> QDE schema: where P is any natural property, necessarily, if *x* has P, then in virtue of *x*'s being P, if *x* were F, then *x* would be G (*ceteris paribus*). (Tugby 2012, 728)

Since I advocate Vetter's conception of dispositions over the standard conception, I'll make a slight departure from Tugby and understand the claim that qualities ground dispositions in terms of qualities grounding *possibilities*, as opposed to counterfactuals. I thus propose the following modification of the QDE schema:

[12] If you think that grounding can only hold between entities of the same ontological category, then "quality Q grounding the truth of modal proposition P" can be read as "the fact that Q exists grounds the fact that P is true".

QDE schema◊: where P is any fundamental property, necessarily, if *x* has P, then in virtue of *x*'s being P, *x* is *possibly* G.

The crucial point to emphasize is that, according to QDE, properties are qualities (and hence differ from one another qualitatively, that is, non-relationally), which ground possibilities/dispositions and this obviates the need to appeal to governing *relations* between properties to *explain* the behaviours conferred by properties, which blocks the regress discussed in section 3.3. The controversial claim, then, is that qualities are capable of grounding possibilities. Just as we may reasonably ask what explains the necessary connection between the facts M(F, G) and R, we may ask how, exactly, qualities ground possibilities. In section 5, I'll attempt to add further plausibility to the latter suggestion, despite its apparent opacity. But before doing so, I would like to highlight a further benefit of QDE over structuralism.

3.5 QDE, Structuralism and Symmetrical Grounding

In this section, I argue that on a plausible and attractive interpretation of structuralism, the structure is ontologically dependent upon properties. Furthermore, the central tenet of structuralism is that properties are metaphysically individuated by their place in a structure, so properties ontologically depend on structure. Hence, properties and structure symmetrically ontologically depend on, or are *grounded by*, each other. QDE, on the other hand, is not committed to symmetrical grounding. What this means is that structuralism requires more basic entities than QDE, namely, properties *and* structure, where QDE need only posit properties at the fundamental level. Even more problematic is the implication for *dispositional essentialism*, according to which properties and *laws* symmetrically ground each other. Symmetrically grounded laws and properties follow from the dispositional essentialist package deal, which comprises a structuralist metaphysics of properties and a view of laws as arcs in the property structure (that this is a plausible interpretation of dispositional essentialism is argued in section 3.5.3). This

result is antagonistic to the dispositional essentialist's desire to metaphysically explain laws in terms of properties, and not vice versa.

3.5.1 Properties Ground Structure

Yates (2017) talks about properties, on the structuralist conception, as *composing* a structure:

> [Structuralism][13] require[s] that entities can be individuated by their places in a structure *composed* by the entities themselves. (Yates 2017, 19, my emphasis).

> In [structuralism], powers are fully individuated by their places in a type-casual structure *fully composed of powers*. (Yates 2017, 20, my emphasis)

But one might object to an understanding of structuralism according to which the structure is *composed* of properties. In other structural*isms*, it would perhaps be inappropriate to talk in terms of some entities composing a structure, so why interpret structuralism about properties in this way? Platonist interpretations of mathematical structuralism and extreme versions of ontic structural realism would seem to be cases in point. I'll briefly discuss these in turn before suggesting that to avoid saying that the structure is composed of properties (or otherwise ontologically dependent upon them), the property structuralist is pushed to either embrace Platonism or the controversial view that there exist relations without relata.

Mathematical structuralists hold that 'mathematics investigates structure' (Cole 2010, 689). What is important to mathematics, on this view, are not the internal natures of its objects but the relations in which its objects stand to one another.[14] Call a collection of objects standing in various relations to each other a

[13] Yates actually uses the term "PPO" here, for "pure powers ontology", but the idea is the same – that all fundamental properties are essentially and exhaustively dispositional and so have their identities fixed by the relations in which they stand to other properties, *viz.* place in a structure.

[14] Note here the similarity to property structuralism according to which the internal natures of properties are exhausted by their relations to other properties.

system. Arabic numerals, Roman numerals and Zermelo numbers are systems in this sense, which all have a common *structure* – the natural number structure – and it is this structure which is the subject matter of arithmetic, according to the mathematical structuralist.

A mathematical structure can thus be understood as a kind of one-over-many universal, though where a traditional universal holds of individual objects, a structure holds of systems (see, e.g., Shapiro 2008, sec. 4). Systems, such as the various number systems listed above, may be thought of as instantiating the natural number structure in a way analogous to how roses, London buses and robins instantiate *redness*. Thus, any of the standard philosophical views about universals can be applied to structures. Shapiro (1997), for example, advocates an *ante rem* version of mathematical structuralism according to which structures are Platonic entities, ontologically independent from any systems which may instantiate them. Terms for mathematical entities, on this view, refer to places in the structure. Aristotelian *in rebus* mathematical structuralism, by contrast, construes structures as universals which exist only in the concrete systems that instantiate them. Structures, on this Aristotelian view, ontologically depend upon concrete systems. Finally, eliminativist mathematical structuralists deny, contrary to both *ante rem* and *in rebus* structuralism, that structures, *qua* universals, really *exist*. Instead, they maintain that talk of structure is just shorthand for generalizations over various concrete systems with structural properties in common.

As will become evident later in this section, Yates' claim that properties compose a structure is only relevant insofar as it implies that the structure ontologically depends upon the properties. Hence, I will rephrase the original question thusly: in other structuralisms, it would perhaps be inappropriate to talk in terms of structure *ontologically depending* on some entities, so why interpret structuralism about properties in this way? Of the three versions of mathematical structuralism briefly outlined above, only the Aristotelian *in rebus* version makes the structure ontologically dependent upon some entities (though as Shapiro notes, no one seems to have developed this view in detail). It is hard to see how to answer the question with respect to eliminativism since, strictly speaking, according to the

eliminativist there are no structures to ontologically depend on anything. In Shapiro's *ante rem* structuralism, however, it is made explicit that the structure is ontologically *in*dependent of anything that may instantiate it – *ante rem* structures are Platonic entities, which would exist whether or not there was anything to instantiate them. So, in a similar vein to the *ante rem* mathematical structuralist, the structuralist about properties may posit the structure as an ontologically independent Platonic entity that properties instantiate. On this construal, it would be false to say that the structure ontologically depends on properties (or anything else).

According to (extreme versions of) ontic structural realism (OSR), individuals are eliminated from the ontology in favour of an ontologically primitive relational structure (e.g., French and Ladyman 2003; Ladyman et al. 2007). *Prima facie* talk about individuals is then understood as merely abstracting from the fundamental relational structure. Since, on this view, structure is all there is, it certainly is not the case that the structure ontologically depends on anything else. Perhaps, then, the structuralist about properties could say something similar, namely, that a relational structure is all there is to properties, in which case it would be false to say that this structure ontologically depends on properties, or anything else. However, this interpretation of structuralism about properties would share with the extreme version of OSR a commitment to relations without relata, which is something that many have found objectionable (e.g., Chakravartty 1998, 2003b; Psillos 2006a).

What this brief survey of other structuralisms suggests is that talk of the structure being composed of, or otherwise ontologically dependent upon, some entities can be resisted. However, the structuralisms discussed that achieve this – Shapiro's *ante rem* mathematical structuralism and extreme OSR – get ontologically independent structures only by incurring certain costs; the former is committed to Platonism and the second to relations without relata. It is open to the structuralist about properties to either embrace Platonism or relations without relata to secure the ontological independence of her structure, however, neither of these views, I suggest, is particularly attractive.

The unattractiveness of relations without relata straightforwardly depends on the idea's affront to common sense. This is expressed, for example, by Chakravartty when he says that "one cannot intelligibly subscribe to the reality of relations unless one is also committed to the fact that some things are related" (1998, 399). However, Bird himself expresses some sympathy for a Platonic conception of universals. He seems to think that Platonism is required for *strong necessitarianism* – the view according to which all possible worlds are identical with respect to the laws of nature (2007, sec. 3.2) – and he does not rule strong necessitarianism out as a viable position. Furthermore, Tugby (2013) argues that only when accompanied by Platonism can a dispositional essentialist account of properties properly respect the following platitudes:

> *instantiation:* a particular can instantiate a disposition even if that disposition is never manifest

and

> *intrinsic:* many dispositional properties are intrinsic to their possessors.

Unfortunately, it would lead me too far astray to thoroughly discuss these arguments of Bird and Tugby, I shall, however, offer some brief comments. Firstly, it is important to note that the attraction of dispositional essentialism in large part inheres in its ability to provide an account of fundamental properties, such as *charge*, *mass*, *spin*, etc., in a way that is continuous with science and to account for laws of nature in terms of those unmysterious, science friendly entities. But the introduction of Platonic transcendent universals – entities that are shrouded in mystery and which do not seem to be within the remit of science – would remove this selling-point. To concede Platonism would greatly compromise what many, myself included, perceive as the strongest motivation for dispositional essentialism. Hence, Bird should perhaps dial back his Platonist sympathies.

In response to Tugby, one might argue that it is far from obvious that failure to respect (philosopher's) "platitudes" about dispositions places sufficient pressure on the dispositional essentialist to embrace Platonism, where Platonism arguably

conflicts with commonplace, as well as scientific, intuitions about what exists and the nature of what exists. In other words, it is not obvious that a failure to respect *instantiation* and/or *intrinsic* comes at a greater intuitive cost than admitting that there exists a Platonic realm populated by necessarily existing, transcendent properties.

So, in the interest of not lumbering the structuralist with either relations without relata or Platonism, it would seem reasonable to follow Yates' understanding of structure as ontologically dependent upon the properties that "compose" it. Though it is perhaps not uncontroversial that composition is the appropriate notion with which to cash out this ontological dependence, to properly address this point would lead me too far astray. I shall thus follow Yates in talking of properties composing a structure but the minimum that is intended by this is the idea that the structure ontologically depends (in some way or other) upon the properties. In other words, it seems plausible that properties *ground* a structure.

Grounding is widely understood as a metaphysical (that is, objective/non-epistemic) explanatory relation (Fine 2012a, 2015). The grounding relation is primarily expressed with the terms "in virtue of" (predicational view) or "because" (operational view) (Correia and Schnieder 2012, 10–11). Thus (assuming that the grounding relation can hold between entities) x grounds y iff y exists in virtue of x and it is metaphysically necessary if x exists then y exists (see Yates 2017, 19). For example, the set {Socrates} exists in virtue of the man, *Socrates*, and it is metaphysically necessary that if Socrates exists then {Socrates} exists too. Thus, we might say that the existence of Socrates metaphysically explains the existence of {Socrates} (but not vice versa). It is also widely held that grounding is transitive and irreflexive and that the ordering thus induced is a relative fundamentality ordering such that a grounded entity is less fundamental than its grounds; if x grounds y, then x is more fundamental than y. According to, e.g., Schaffer (2012, 125) it is useful to think of grounding as a relative fundamentality ordering in this way because it imposes metaphysical structure on the world and helps with the formulation of interesting philosophical theses such as *physicalism* – the thesis that everything either is, or is grounded in, the physical.

3.5.2 Symmetrically Grounding Properties and Structure

Properties, according to structuralism, are individuated by their positions in a structure grounded by those very properties. Now we may ask (as Yates 2017, 23 does): which is more *fundamental*, the structure or the properties? Metaphysical individuation is a grounding relation; if A metaphysically individuates B, then B ontologically depends on A. And if grounding is a relative fundamentality relation, then structure must be more fundamental than properties because structure metaphysically individuates and hence *grounds* the properties. But, as argued above, unless one is happy to embrace either Platonism or the controversial thesis that there exist relations without relata, then structuralism seems to imply that properties ground the structure, which, again assuming that grounding is a relative fundamentality relation, implies that properties are more fundamental than the structure. We have thus arrived at the absurd result that properties are more fundamental than structure and structure is more fundamental than properties. This absurdity was yielded by the following premises:

i) Ground is a strict partial order (it is transitive, irreflexive and asymmetric) from the more to the less *fundamental*; if a grounds b, then a is more fundamental than b.
ii) Properties ground the structure.
iii) The structure metaphysically individuates, and hence grounds, the properties.

The structuralist is pushed to embrace premise ii) in order to avoid Platonism or a commitment to relations without relata (as argued above). And premise iii) is at the very heart of structuralism: to deny that properties are metaphysically individuated by their place in a structure because they are, say, self-individuating (as per QDE), would just be to deny structuralism. According to Yates (2017), then, the best way for the structuralist to resolve the absurdity is to maintain

that properties and structure are equifundamental and symmetrically grounded in each other, which is to deny i).

In support of this suggestion, Yates point out that, unorthodox though it may be, there is no purely ground-theoretical objection to the idea that ground is non-asymmetric and hence to the idea that i) is false. For example, Rodriguez-Pereyra (2015) offers the following counterexample to the asymmetry of ground: if we let the proposition E = <F is true> and F = <E is true> and assume both E and F are true, then the fact that E is true grounds the fact that F is true, and the fact that F is true grounds the fact that E is true (2015, 529) (see also Thompson 2016, 47). And Thompson (2016) suggests that an organism is partially constituted by its organs and that organs are identity dependent on the roles they play within the organism. On the assumption that constitution and identity dependence are grounding relations, it follows that the organism and its organs are symmetrically grounding (see also Yates 2017, 20). Furthermore, Yates argues that *ontic structural realism* is best understood in terms of objects and structure symmetrically grounding each other (Yates 2017, 22–23). Structuralism is thus not peculiar for implying the non-asymmetry of ground.

3.5.3 Symmetrically Grounding Properties and *Laws*

Even if there is no purely ground-theoretic objection to denying premise i), I'd like to suggest that it forces the dispositional essentialist (where recall that dispositional essentialism includes a structuralist view of properties) into an uncomfortable position. Part of the attraction of anti-quidditist views in general is the promise of a metaphysical explanation of *laws of nature.* A thought common among anti-quidditist metaphysics is (roughly) that if properties are powerful because they are essentially connected with the behaviours that they confer upon their bearers, then one can account for the most general patterns in property distributions – of *laws* – in terms of those powerful properties themselves. Dispositional essentialism is touted as superior to *best systems analyses* of laws (e.g., Lewis 1994; Lewis 2001) and so called *nomic necessitation* accounts (e.g., Dretske 1977; Tooley 1977; Armstrong 1999) because the former do not endow the laws with the metaphysical "oomph" and

hence *explanatory power* that we take them to have, and the latter render the laws mysterious external governing forces.

Now consider the following remarks from Bird concerning the relationship between properties and laws:

> Since *laws flow from the essences of potencies*, they must hold in every possible world (Bird 2007, 5, my emphasis) (recall that by "potencies" Bird means fundamental, essentially dispositional, properties).
>
> If properties have a dispositional essence then certain relations will hold of necessity between the relevant universals; these *relations we may identify with the laws of nature*. (Bird 2007, 43, my emphasis)
>
> laws are general *relations* among properties (Bird 2007, 200, my emphasis)
>
> laws are general *relationships* (Bird 2007, 202, my emphasis)
>
> laws reflect the essential rather than accidental features of potencies and kinds (Bird 2007, 202)

What is clear from these remarks is that Bird takes the laws to be general relationships between properties, which "reflect" or "flow from" the essences of those properties. Since M-relations are relations among properties, which *constitute* (according to structuralism and hence according to dispositional essentialism) the *essences* of those properties, M-relations would certainly seem to fit the bill here.

To be clear, the claim is not that M-relations hold between particular property instances, rather, M-relations are *general* relations that hold between, and constitute the essences of, properties themselves and thus have implications for the behaviours of *instances* of those properties. What is eminently plausible, then, is that M-relations, that is, the manifestation relations in which properties stand to each

other, just *are* the laws, according to the dispositional essentialist – this is particularly consonant with the second of the quotes from Bird above.[15]

Another dispositional essentialist who is even more explicit about the idea that laws are just relations between essentially dispositional properties is Chakravartty:

> [N]ot only are laws composed of relations between causal properties; they distinguish and identify properties as well. (2003a, 394)

> In a world inhabited by different causal properties, the relations we would there describe as causal laws would be, *ipso facto*, different as well. (2003a, 402)

> Causal laws are never vacuous in principle, given that they are relations between causal properties. (2003a, 405)

It would thus seem to be a popular dispositional essentialist move to identify M-relations, which are *arcs* in the property structure, with the laws of nature.

Now, if you fix the M-relations, *viz. laws*, at a world, *w*, you fix the property structuralist's structure at *w*. If we let [M] denote the plurality of M-relations/laws at a world, *w*, and let S denote the property structure at *w*, then we may ask the following question: what is the relationship between [M] and S? Answer: *identity*. The plurality of M-relations at a world, *w*, *just is* the structure at *w*.

If the collection of M-relations, [M], at a world, *w*, and the property structure, S, at *w* are identical, then anything true of S must be true of [M] too. According to structuralism, the structure, S, at *w* grounds the properties at *w* because it metaphysically individuates them. But if S grounds the properties at *w* then [M] must ground properties at *w* too, since S and [M] are identical. But M-relations, I have argued, just are the structuralist's laws. Thus, the collection of M-

[15] Of course, since Bird understands dispositional properties in terms of their stimulus and manifestation conditions, it would be more accurate to attribute to Bird the view that laws are *three-placed* relations between stimulus, potency and manifestation. But nothing of substance hangs on this.

relations at *w*, [M], is just a collection of laws. To say that [M] grounds properties, then, just is to say that *laws* ground properties, on the structuralist picture. To be clear, the argument runs as follows:

i)	S=[M]	
ii)	[M] is a collection of laws	
iii)	S grounds properties	(central tenet of structuralism)
iv)	[M] grounds properties	(from i, iii and Leibniz's Law)
v)	Laws ground properties	(from ii and iv)

But this is antagonistic to any *explanatory* aspirations that the dispositional essentialist may have to explain laws in terms of properties. As mentioned, grounding is plausibly understood as an explanatory relation distinct from, but analogous to, say, *causation* (Fine 2012a, sec. 1), see also Schaffer (2016); just as one may explain some fact A by saying that some temporally prior fact B *caused* it, one may explain A in terms of B by saying that B *grounds* A. An explanation of A in terms of B will not do, however, if in order to explain B, we must appeal to A – this kind of *circularity* of explanation is vicious. The type of explanation of the laws that the dispositional essentialist should seek to provide is a grounding explanation whereby essentially powerful properties ground laws. But if laws ground properties too, the explanation is circular and, thus, arguably fails to satisfy a key motivation for dispositional essentialism, which was to explain laws in terms of properties, not vice versa.

Perhaps the most obvious response to the symmetrical grounding problem for DE would be to deny that laws are identical with M-relations and maintain instead that laws are universal generalizations of the form $\forall x(Fx \rightarrow Gx)$. Bird himself canvasses this option: "According to the regularity version of dispositional essentialism about laws, laws are those regularities whose truth is guaranteed by the essentially dispositional nature of one or more of the constituent properties" (Bird 2007, 46–47). While it is plausible that the plurality of M-relations grounds properties for the reasons discussed, it does not seem to be the case that a collection

of *regularities* of the form ∀x(Fx→Gx), that is, of linguistic entities, ground properties. Regularities are not identical with M-relations. The property structure can *asymmetrically* ground regularities, so by taking the laws to be identical with such regularities, the problem of symmetrically grounded laws and properties does not get going.

As mentioned, Bird entertains the option of identifying laws with regularities. However, he entertains this possibility only very briefly in a single paragraph, which is directly followed by a more detailed examination of the option of treating laws as *relations* between properties. And in the quotes presented above, Bird certainly seems to lean heavily towards the view of laws as relations. Bird's official statement of what the laws are comes near the end of his book when he says:

> The laws of a domain are the fundamental, general explanatory *relationships* between kinds, quantities, and qualities of that domain, that supervene upon the essential natures of those things. (Bird 2007, 201, my emphasis).

Here Bird explicitly identifies laws with *relationships*, though the reference to supervenience perhaps complicates things a bit. If A supervenes on B, that just means that there can be no change in A without a corresponding change in B. M-relations are general relationships between properties that constitute the essences of properties. This gives rise to necessary connections between properties and the M-relations that constitute their essences. Since M-relations are necessarily connected with the properties that they relate and whose essences they constitute, there can be no change in the pattern of M-relations without a corresponding change in what properties exist, thus it is accurate (though perhaps not the full story) to say that M-relations supervene on properties.

Chakravartty (2003a) argues that the dispositional essentialist ought to identify laws with relations among properties as opposed to regularities on the grounds that doing so yields a response to the problem of vacuous laws. Many laws, such as the ideal gas law: PV = nRT, are vacuous because they apply to systems that do not exist – there are no *ideal* gasses anywhere in the universe. If

laws are *identified* with regularities, such as PV = nRT, then these laws will come out vacuous, which seems odd. But, if we identify laws not with regularities, but with relations between properties, we can avoid the result that idealisation laws, which are ubiquitous, are vacuous. This way, Chakravartty argues, vacuity can be understood as attaching to linguistic entities, *viz*. regularities, whereas the laws themselves, understood as relations between properties, such as M-relations, will not be vacuous because they will hold so long as the relevant property structure is instantiated at a world.

To sum up this subsection: it is clearly very tempting for the structuralist to identify laws of nature with M-relations, that is, arcs in the property structure. Doing so, however, threatens to compromise the structuralist's explanatory aspirations.

3.5.4 QDE vs. Structuralism: Checking the Score

Let's take a moment to take stock and compare the merits of QDE and structuralism and the implications for dispositional essentialism.

In section 3.5.2, I showed that the conjunction of three premises:

i) Ground is a strict partial order (it is transitive, irreflexive and asymmetric) from the more to the less *fundamental*; if a grounds b, then a is more fundamental than b.
ii) Properties ground the structure.
iii) The structure metaphysically individuates, and hence grounds, the properties.

leads to an absurdity according to which properties and structure are each more fundamental than the other. It was argued that the *structuralist's* best option for avoiding this flat contradiction is to deny premise i) and maintain that properties and structure are *equifundamental* and symmetrically grounded in each other.

Another option out of the absurdity is to reject structuralism in favour of QDE, the view that properties are self-individuating *qualities* that ground

dispositions and hence ground a structure of relations. This constitutes the denial of premise iii). Properties, according to QDE, are not ontologically dependent upon any structure of M-relations among properties, or *dispositions*, because they are not metaphysically individuated by their position in any such structure. Properties, according to QDE, are self-individuating – their essences can be specified independently of any relations or dispositions. This is much the same as the way in which the essences of geometrical properties, such as *sphericity*, can be specified independently of any relations or dispositions: "For an individual x to be spherical is for x to have a boundary surface all points on which are equidistant from a given point" (Lowe 2010, 19). Thus, QDE is not, where structuralism is, committed to symmetrical grounding. By rejecting premise iii) and endorsing QDE, one can retain the assumption that ground is a strict partial order. If one is particularly wedded to the asymmetry of ground, then this constitutes a reason to favour QDE over structuralism. Furthermore, these results show that QDE is committed to fewer ontologically basic entities than structuralism. Structuralism is at least committed to properties and structure, whereas QDE need only posit properties. Thus, given QDE, properties can be our sole primitive in terms of which other phenomena, such as dispositions, laws, and modality are explained.

It was suggested that a commitment to symmetrical grounding is not devastating *per se* because various authors have proposed counterexamples to the asymmetry of ground. However, the symmetrical grounding ushered in by structuralism *does* have a devastating result for *dispositional essentialism*, where "dispositional essentialism" refers to the specific combination of a structuralist metaphysic of properties and a view of laws of nature as arcs in the structure, or *M-relations*. Dispositional essentialism, it turns out, cannot non-circularly explain laws in terms of properties because laws and properties are symmetrically grounded in each other. QDE presents a way of rescuing something of the dispositional essentialist package. Plausibly, given QDE, properties ground a structure of M-relations among properties without themselves being ontologically dependent upon that structure; properties, according to QDE, asymmetrically ground a structure. If we continue to assume that M-relations are laws, QDE, allows for properties to

asymmetrically ground and, hence, provide a non-circular metaphysical explanation of the laws.

As it happens, I will present (in chapter 4) a different account of the laws of nature and how they stand in relation to basic properties. On my account, laws are not M-relations, rather, they are features of a strong, simple description of all possible property distributions. This, I will argue, captures the idea that there is a pragmatic dimension to the laws' status as *laws*; laws are those true generalizations that are particularly useful *to us* in our practical and scientific pursuits. M-relations, by contrast, will often be highly specific and limited in scope.

The considerations of this section thus constitute a case against *dispositional essentialism* understood very specifically as an attempt to explain laws in terms of properties and which endorses a structuralist metaphysic of properties and according to which laws are M-relations. The considerations of this section also constitute a case in favour of QDE over structuralism; they show that QDE avoids a commitment to symmetrical grounding, which while not a deal-breaker, is an oddity that is perhaps best avoided if possible. And relatedly, the considerations of this section also show that QDE is committed to fewer ontologically basic entities than structuralism. Structuralism is committed to properties and structure both being basic, whereas QDE need only be committed to properties at the ground-floor level.

What I do not wish to claim, however, is that we should opt for QDE over structuralism on the grounds that the former, and not the latter, allows properties to asymmetrically ground laws *qua* M-relations. This is because, *contra* the dispositional essentialist, I do not think that M-relations are plausible candidates for laws anyway and so rescuing an account according to which M-relations are laws and are explained in terms of properties does not motivate me. Furthermore, it is open to the structuralist to deny that M-relations are laws. They might, instead, take laws to be descriptions of the property structure. Thus, while the properties and structure symmetrically ground each other, they might each be said to asymmetrically ground the laws *qua* descriptions. It's important to emphasize, then, that the symmetrically grounded laws and properties concern targets only the

specific combination of views constitutive of dispositional essentialism and does not itself tell in favour of QDE over structuralism. As mentioned earlier, I take the symmetrically grounded laws and properties concern to be a more precise articulation of the vague sense of dissatisfaction with dispositional essentialism's strategy of building laws into property essences and then claiming to explain the laws in terms of those very essences.

3.6 Qualitative Dispositional Properties

In this chapter, I have presented three reasons to favour QDE over structuralism as a metaphysic of properties:

1. QDE is better placed than structuralism to provide an explanation of the spacetime distribution of property instances (argued in sections 3.3 and 3.4).
2. QDE is not, where structuralism is, committed to the non-asymmetry of ground (argued in section 3.5).
3. QDE is committed to fewer ontologically basic entities than structuralism (argued in section 3.5).

It was also argued, in section 3.5, that dispositional essentialism, which incorporates a structuralist metaphysic of properties, cannot non-circularly explain laws in terms of properties. Though I concede that this argument does not necessarily tell in favour of QDE over structuralism, it only tells against the specific combination of views constitutive of dispositional essentialism. But for all that *has* been said in favour of QDE, perhaps there is still opacity to the suggestion that *qualities* ground dispositions.

QDE, on my preferred construal, explains the space-time distribution of properties in terms of those properties grounding certain dispositions, which, I have suggested, is tantamount to their grounding certain possibilities for their bearers. For example, if *x* instantiates *fragility*, then possibly *x* instantiates *shattering*, or, if *x* instantiates *positive charge*, then possibly *x* instantiates the property of accelerating towards an instance of negative charge. The possibility in the latter case is

"stronger" than that in the former case because the relevant potentiality is a *lower-level* potentiality and so only possessed to a particularly high degree (see section 3.2). The opacity concern is a challenge to add plausibility to the claim that *qualities* ground dispositions/possibilities. As Tugby puts it "…opponents […] might object […] that the alleged internal connection between qualities and dispositions is itself pretty opaque." (2012, 729).

Recall that the explanatory challenge for structuralism (section 3.3) was a challenge to say why it is that in all worlds in which, e.g., M(F, G) = the fact that the M-relation holds between F and G, holds, the regularity R = the fact that if x is F then x is disposed to manifest G, holds too (see Barker and Smart 2012). This challenge forced the structuralist to either embrace regress or say that it is just a brute fact that necessarily whenever M(F, G) holds, R holds. The latter option, it was complained, is unsatisfactory because to posit a brute necessary connection in this way is unexplanatory and against the spirit of dispositional essentialism (and besides, the same strategy would rescue the Armstrongian view, to which structuralism was proposed as a superior alternative). But is it really any more explanatory to say that, e.g., positive charge, *qua* quality in the QDE sense, grounds a disposition to accelerate towards instances of negative charge than to say that there is a brute necessary connection between the relevant properties? I'll attempt to answer the latter question in the affirmative by adding independent plausibility to this grounding claim.

There is, I suggest, a difference between *merely stipulative* grounding claims and grounding claims that are not *merely* stipulative because they enjoy some intuitive support too. Consider the following:

a) Socrates grounds {Socrates}
b) The fact that the ball is red and the fact that the ball is round ground the fact that the ball is red and round (Fine 2012a).

The grounding claims in a) and b) are not *merely* stipulative, they needn't just be taken on *faith*, because they are intuitively plausible. Now the concern according to

which the claim that qualities ground dispositions is *opaque* is, I suggest, a concern that this grounding claim is *merely* stipulative. Unlike a) and b), the claim that, e.g., positive charge (understood as a *quality*) grounds a disposition to accelerate towards instances of negative charge enjoys no intuitive support – it must just be taken on faith, or so the objection may go. And if we must take this grounding claim on pure faith, then QDE would seem to be in no better position than structuralism complete with brute necessary connections.

However, the idea of qualities grounding dispositions is not opaque *in general*. Geometrical properties, such as *sphericity*, are generally taken to be paradigm qualitative properties. Sphericity can be individuated and understood completely independently of any dispositions it may confer or any relations in which it may stand to other properties. For an individual x to be spherical is for x to have a boundary surface all points on which are equidistant from a given point (Lowe 2010, 19). Sphericity also (partially) grounds possibilities for its bearers; x's sphericity is a (partial) ground of the possibility that x rolls down an incline, that x casts an elliptical shadow, that x *looks* spherical under normal conditions (the ground is partial because x must also be heavy, rigid, etc. in order to roll and it must not be completely see-through in order to cast a shadow or be seen). The claim that sphericity grounds the possibility of rolling is completely transparent – we can just intuitively "see" how it is in virtue of x's sphericity that x can roll. Thus, we may add to our list of grounding claims that are not *merely* stipulative, because they enjoy some intuitive support:

c) The fact that x is spherical grounds the fact that x can roll.

Now I suggest that the claim that, e.g., positive charge (*qua* quality in the QDE sense) grounds a disposition to accelerate towards instances of negative charge enjoys additional plausibility given that there are claims of ground obtaining between quality and disposition, which are very intuitive, as illustrated by c). There is no obstacle *in principle* to qualities grounding dispositions and indeed such grounding claims are eminently plausible when the quality concerned is a familiar

geometrical property. Since positive charge and sphericity are both qualities, and since the latter so clearly grounds a disposition, it seems at least plausible that the former ground dispositions too, as indeed QDE maintains it does. Compare this with the following grounding claim:

PHYS: the physical grounds the mental.

PHYS, I suggest, doesn't enjoy the sort of eminent plausibility enjoyed by claims a-c. Nor even is there any intuitively plausible grounding claim *analogous* to PHYS, which may indirectly lend support to PHYS. Sphericity grounding rolling is analogous to positive charge grounding acceleration towards negative charge because both are cases of *qualities* grounding *dispositions* and, hence, the intuitive plausibility of the former indirectly supports the latter. No such case can be made for PHYS. PHYS perhaps gains support via its various theoretical virtues, but aside from those, it is *merely* stipulative. And yet PHYS is widely accepted. The claim, central to QDE, that qualities ground dispositions, is in at least as good a state as PHYS – both enjoy support from their theoretical virtues. However, the former gains additional support from the observation that it is analogous to a very intuitively plausible grounding claim. I thus suggest that any opacity there may be to the claim that low-level properties, such as positive charge, *qua* qualities, ground dispositions is not sufficient reason to reject such grounding claims outright. QDE gains support from its various theoretical virtues and from the observation that there are cases in which a quality grounding a disposition is utterly transparent.

Now reconsider the question above: is it really any more explanatory to say that, e.g., positive charge, *qua* quality in the QDE sense, grounds a disposition to accelerate towards instances of negative charge than to say that there is a brute necessary connection between M(F, G) and R? That is to say, is QDE really any better off than structuralism with brute necessary connections? I note first that QDE is at least *dialectically* superior. According to structuralism, it is ultimately the second order relational facts that do the work of governing first order property instantiations, which perhaps runs counter to the dispositional essentialist desire to

endow the first order properties themselves with this constraining power (see Tugby 2012, 726). Furthermore, it is just as open to the Armstrongian to posit brute necessary connections in response to the kind of regress discussed in section 2, so structuralism, it would seem, is really no better off than the Armstrongian view to which it was proposed as a superior alternative. What is more, it is *not* open to the Armstrongian to ground dispositions in the essences (qualitative or otherwise) of properties because he is committed to a version of quidditism according to which properties have no non-trivial essential natures capable of entering into any such grounding relations (see Tugby 2012, 729). Properties, according to Armstrong, are just primitively numerically self-identical and distinct from each other, thus there are no qualitative *differences* among properties, which could account for different properties being grounds for different dispositions. So QDE, unlike structuralism, is able to explain facts about property instantiations at space-time regions in a manner that is *not* available to the Armstrongian.

But in light of the considerations of this section, I think it is fair to say that QDE is not merely dialectically superior to structuralism. The claim that, say, positive charge grounds a disposition to accelerate towards instances of negative charge is (slightly) more explanatory than the claim that there is a brute necessary connection between M(F, G) and the regularity R. This is because the former, unlike the latter, enjoys some (modest) indirect support from the fact that in there are other cases in which it is eminently plausible that a quality grounds a disposition, such as the case of sphericity grounding rolling.

3.7 Scepticism

In addition to the opacity concern, there is a potential sceptical worry for QDE which arises because QDE appears to be consistent with its being the case that two or more properties ground the exact same range of dispositions.

QDE is reminiscent of what Hawthorne calls the 'double aspect view'. (2001, 362). According to the double aspect view, properties are dispositional, but the dispositional aspect of a property, P, does not *exhaust* P's nature. P has a non-dispositional, or *qualitative*, aspect too. Hawthorne takes this view to be consistent

with the possibility that two qualitatively distinct properties, P and P', both essentially confer the exact same dispositions. Similarly, according to Tugby, it is consistent with QDE that "two properties could confer certain powers essentially, yet also be distinct in virtue of some qualitative, categorical difference" (2012, 727). Smith (2016) considers the view that she calls *non-recombinatorial quidditism*, according to which: "distinct fundamental properties are qualitatively different despite the fact that those qualitative differences are primitive and unanalysable" and "qualitative differences between fundamental properties […] place restrictions on the ways in which instantiations of the fundamental properties can be recombined in space and time."(2016, 249–50). This view differs from structuralism in that the identity and distinctness of properties is determined not on the basis of the dispositions they confer/their nomological roles, but by the distinct qualitative natures that they are. Nevertheless, qualities, according to non-recombinatorial quidditism, *ground* dispositions. (Smith 2016, 250–51). Smith's non-recombinatorial quidditism is thus, I submit, very close to QDE, if not just the same view by another name. And, crucially, non-recombinatorial quidditism, according to Smith, does not rule out the possibility that distinct fundamental properties confer the exact same set of dispositions (Smith uses the term *nomological profiles*) (Smith 2016, 251, 256).

The possibility that distinct properties are responsible for the same dispositions does "serious damage to our concept of a property", according to Bird (2007, 77) (see also chapter 1, section 1.2.2). We might take ourselves to understand the concept of, say, positive charge as the property responsible for a disposition to accelerate towards instances of negative charge. Hence, we plausibly fix the reference of theoretical terms, such as "positive charge" via dispositions – "positive charge" refers to the property in virtue of which individuals are disposed to accelerate towards instances of negative charge. But if it is possible that two or more distinct properties are responsible for the disposition to accelerate towards instances of negative charge, then, as Smith puts it, we would have no conception of the properties that satisfy the predicate "positive charge" (see Smith 2016, 256). In other words, if two or more properties are responsible for the disposition to accelerate towards instances of negative charge, then our theoretical term "positive charge",

explicated as *the property* responsible for the disposition to accelerate towards instances of negative charge, will fail to get its reference fixed (compare the failure of reference of "the player on the pitch" when uttered by a fan in attendance at an 11-a-side football match). Since we cannot know whether ours is a world in which two or more properties are responsible for the dispositions associated with positive charge, we cannot know whether our theoretical term "positive charge" is referential. And there is nothing unique about "positive charge" in this respect, the point will extend to other theoretical terms for fundamental properties. According to Bird:

> The possibility of reference-failure of theoretical terms is not itself a problem – we know this possibility to be actualized in some cases. What is worrying is the thought that we can never know that the possibility is not actualized for any theoretical term – we never know whether any such term refers. (2007, 77)

Plausibly, properties such as positive charge are responsible for various dispositions/behaviours/possibilities (I use these interchangeably in the present context). For example, a positively charged individual, x, can, in virtue of being positively charged, accelerate towards instances of negative charge, but x can also radiate electromagnetic radiation if accelerated. Call the set of all and only the possibilities grounded by a given property, P, the *modal profile* of P. Thus, included in the modal profile of positive charge are the properties of accelerating towards an instance of negative charge and emitting electromagnetic radiation. Beyond the possibility that distinct properties ground the same disposition, the considerations above would seem to suggest that two (or more) distinct properties, e.g. P and P', could share the exact same *modal profile* because P grounds *all and only* the dispositions that P' grounds. Hence, we could never know if we have found a set of dispositions uniquely grounded by a single property via which we might establish a conception of the property and the reference of a theoretical term. The scepticism, it would seem, is irremediable in principle because no matter how many dispositions

we associate with a property and how much better we take our conception of "that property" to be, we cannot know whether or not we are indeed dealing with multiple distinct properties.

This sceptical worry is linked to the opacity concern. If the grounding relation between, e.g., quality, Q, and modal profile, MP_Q, is opaque, which is to say that its holding must just be taken on faith, then granting that such a grounding relation does obtain does nothing to rule out the possibility that some distinct quality, Q', also grounds MP_Q. If, however, the grounding relation were more transparent, then perhaps we could discern some reason to rule out the possibility of distinct properties having the same modal profile. If no two properties could share the same modal profile, then we could at least hold out hope of discovering the full modal profile of a property and thereby settling our concept of the property and the reference of a theoretical term for the property via its unique modal profile.

As discussed, the grounding relations between *sphericity* and the dispositions that constitute its modal profile are transparent in a way that the purported grounding relations between *positive charge* and the dispositions that constitute *its* modal profile are not (the arguments of this section apply equally to other low-level physical properties, such as *mass*, *spin*, etc.). We can just "see" how an individual's sphericity is a ground of its possibly rolling down an incline, casting an elliptical shadow, *looking* spherical, etc. Hence, the *opacity concern* raised against QDE would not seem to apply to sphericity; there is nothing mysterious about a claim such as *it is possible that x rolls down an incline in virtue of the fact that x is spherical*. Is anything analogous to the sceptical concern for QDE applicable in the case of *sphericity*? In other words, is it possible for two or more distinct properties to be have the exact same modal profile as sphericity? It certainly seems unlikely that it is. Other properties perhaps ground *some* of the dispositions that sphericity grounds; being *egg-shaped* or *bagel-shaped* perhaps ground possible rolling. *Cylindricity* perhaps grounds possible rolling, casting an elliptical shadow or even looking spherical – or at least circular (from the right angle anyway). But sphericity and cylindricity do not share the same modal profiles. A cylindrical object can also cast a rectangular shadow, depending on the position of the light source relative to

the cylinder and the surface on which the shadow is cast. Thus, cylindricity grounds a possibility that sphericity does not – sphericity and cylindricity have different modal profiles. It is, I suggest, difficult to conceive of a property having the exact same modal profile as *sphericity* without that property just being *sphericity*, and this at least lends some support to the idea that it is *impossible* for any property distinct from *sphericity* to have the same modal profile as *sphericity*.

Now if "sphericity" is shorthand for "the property with such and such a modal profile" and if, as seems plausible from the above examples, no distinct property shares a modal profile with *sphericity*, then no sceptical concern arises for sphericity analogous to that raised for, e.g., *positive charge*, given QDE. It is eminently plausible that we are *not* irremediably ignorant of whether or not our term "sphericity" is referential.

Why the difference between, e.g., *positive charge* and *sphericity*? Why is it that we can make sense of sphericity grounding rolling but not positive charge grounding acceleration towards negative charge? Why can we be relatively confident that no other property shares sphericity's modal profile, yet we think it possible that multiple properties share the modal profile that we associate with positive charge? My suggestion is that these differences of opinion in each case are unfounded and should be rejected.

In the case of *sphericity*, we can intuitively "see" how it grounds the dispositions constitutive of its modal profile and, hence, we struggle to conceive of a distinct property having the exact same modal profile as *sphericity*. Whereas in the case of positive charge we cannot intuitively "see" how it grounds the dispositions constitutive of its modal profile, so it appears to be possible that two or more properties have the exact same modal profile that we associate with *positive charge*. But we should not take this lack of intuitive (or optical) perception as conclusive evidence against the hypothesis that *positive charge* is nonetheless completely analogous to sphericity in these respects. On the contrary, it would be unfounded, I suggest, to admit that although *sphericity* and *positive charge* are both *qualities*, which ground dispositions, they are so different in this important respect. Just because positive charge is not accessible to our senses in the way that sphericity is, we

should not assume that it cannot, in virtue of its qualitative nature, explain the behaviours of positively charged individuals. Nor should we assume that it is possible that some quality distinct from positive charge grounded the exact same set of dispositions that positive charge grounds.

The considerations of this section are far from knockdown arguments (though a piece of philosophy's failing to constitute a knockdown argument should hardly count against it). Rather, they are merely intended to go at least some way towards quelling the concerns one may have with the idea that qualitative properties ground possibilities. This grounding claim is eminently plausible and does not lead to scepticism in the macroscopic case of sphericity, so why think things are different for low-level properties? The considerations of this section are thus intended just to add at least some plausibility to QDE. But in all honesty, if one takes the considerations of this section to add nothing at all, that is a shame but it is not devastating since the most important arguments for QDE came in earlier sections where it was shown how QDE avoids the explanatory regress and symmetrical grounding problems, which are faced by structuralism.

3.8 Conclusion

I have bolstered the case for *qualitative dispositional essentialism* (QDE) by showing how it is superior to structuralism in three respects: i) it avoids Barker and Smart's "ultimate argument" (2012) ii) it avoids commitment to symmetrical grounding and relatedly, iii) it is committed to fewer ontologically basic entities than structuralism. I have also used the examination of structuralism to show that dispositional essentialism cannot provide a non-circular explanation of laws in terms of properties. Finally, I attempted to dispel concerns that the claim that qualities ground dispositions is opaque and, hence, leads to scepticism, by showing that such problems do not arise at the macroscopic level.

4. HUMEAN LAWS IN AN UNHUMEAN WORLD[16]

4.1 Introduction

In this chapter, I present the details of my positive account of the laws of nature and, hence, my positive account of the relationship between laws and properties. I suggest that we be Humean about the laws, in the sense of providing metaphysically thin, and partly pragmatic, grounds for what it is for some proposition to constitute a law of nature, while also embracing the unHumean metaphysics of properties defended in chapter 3 (namely, QDE). The present account is in large part motivated by the concerns, discussed in the previous two chapters, of simply building laws into the essences of properties and then purporting to explain those very laws in terms of those very properties, as well as by the idea that there is a certain pragmatic basis for some proposition's being elevated to the status of *law*. The view is also motivated by considerations in favour of denying R-quidditism (discussed in chapter 1) and by the belief that a thin view of laws is all that is needed once an anti-quidditist, conception of properties is embraced (see Demarest 2017). Interestingly, then, the best account of laws might turn out to be one which combines elements of the Humean and the anti-Humean views which have for a long time been in fierce disagreement.

My discussion in this chapter shall proceed as follows. Section 4.2 frames the debate by providing some background on *Humean* laws and ontology in contrast with *unHumean* laws and ontology with the intention of highlighting how one's ontology (be it Humean or unHumean) may affect what one has to say about the laws of nature. Section 4.3 anticipates a concern according to which it would be ill-motivated to combine Humeanism about laws with an unHumean ontology, which, in turn, allows me to identify two desiderata on an account of laws deserving of the

[16] This chapter is largely based on my (2017) article of the same name, published in the *Journal of the American Philosophical Association*.

name "*best-system account*". Section 4.4 discusses Heather Demarest's pass at combining a Humean account of laws with an unHumean ontology. I'll argue that Demarest's Potency-BSA risks making the laws epistemically inaccessible to us. Section 4.5 suggests a revision to Demarest's Potency-BSA, which I'll argue avoids scepticism *and* satisfies the desiderata identified in section 4.3. Furthermore, I'll argue that the specific combination of views advocated here, namely, QDE and the Revised Potency-BSA, is superior to the alternatives. Section 4.6 discusses a potential further benefit of my Revised Potency-BSA according to which it might evade the "Big Bad Bug" (Bigelow, Collins, and Pargetter 1993) that afflicts Lewis' Humean laws-ontology package. And in section 4.7, to conclude, I explicitly address how the present view can overcome the problems raised for DE in chapter 2.

4.2 Background: Laws and Ontology

4.2.1 Humean Laws and Ontology

David Lewis popularized the combination of a neo-Humean ontology that he called "Humean Supervenience" and the best-system analysis of laws (BSA). I'll briefly discuss these elements in turn.

> Humean Supervenience is named in honor of the greater [sic] denier of necessary connections. It is the doctrine that all there is to the world is a vast mosaic of local matters of particular fact, just one little thing and then another. (Lewis 1986, ix)

Lewis refers to the "vast mosaic of local matters of particular fact" as the *Humean Mosaic*, I shall use this terminology in subsequent discussion.

The basic properties countenanced by Humean Supervenience are *quiddities*; the Humean's properties bear no necessary connections to their causal or nomological roles. The property *charge*, in our world, occupies a certain role; it confers upon its bearers a disposition to exert a force on other charged bodies in

accordance with Coulomb's law. But, according to the quidditist, this role occupancy is thoroughly contingent. There are worlds in which *charge* confers no causal role at all, and worlds in which it plays the role that we at the actual world associate with *mass* (see chapter 1, section 1.2 for details). It is these *quiddistic* properties of, or instantiated at, points, and their spatiotemporal relations that make up Lewis's neo-Humean ontology.

Now imagine that God wanted to convey to us all the facts about the Humean Mosaic. To this end he might give us a big book that listed the spatiotemporal location of every fundamental property instance. But this would not be very useful for us insofar as we were interested in having the information readily accessible to our finite intellects. A better option might be to provide us with fewer, more general statements about the distribution of qualities throughout the Humean Mosaic, from which we could *deduce* additional information, not explicitly given. A more informative such systematization will have more basic statements, more *axioms* if you like. A simpler systematization will have fewer axioms but will sacrifice informativeness. Hence, the virtues of informativeness and simplicity of a system compete. According to the BSA, the fundamental laws are the axioms of the system that strikes the optimal informativeness-simplicity balance.

Balancing the virtues of informativeness and simplicity in this way will involve a collective consideration of the mosaic *as a whole*:

> [A]n adequate analysis must be collective. It must treat regularities not one at a time, but rather as candidates to enter into *integrated* systems. (Lewis 1983, 367, my emphasis)

Adding to the system a statement like "all electrons are negatively charged" might increase complexity at little to no informative gain if this *regularity* followed from some more general statement of, say, quantum theory. The point is that the BSA treats regularities collectively as candidates to enter into an *integrated* system because matters of fact far beyond those concerning any given regularity, or the participants in a regularity, considered in isolation, will be relevant to that

regularity's status (or lack thereof) as a law. This is an important feature of the BSA to which I shall return in section 4.3 when I consider how an account of laws in an *unHumean* world might be deserving of the name "BSA".

4.2.2 unHumean Laws and Ontology

Any ontology that admits modal properties or necessary connections that do not reduce to some non-modal features of the ontology is unHumean. Two, quite different, examples of unHumean ontologies, already encountered, are Dispositional Essentialism (DE), e.g., Bird (2007) and the Nomic Necessitation view, e.g., Armstrong (1999).

According to DE, fundamental properties are not quiddities because their nomological roles constitute their real essences. In all possible worlds, the property *charge*, for example, disposes its bearers to exert a force on other charged objects in accordance with Coulomb's law because Coulomb's law is part of the real essence of *charge.* There is no possibility of *charge* switching roles with *mass* on this view. Hence, Dispositional Essentialists maintain that there are necessary connections between properties and the laws of nature that constitute their essences (see chapters 1 and 2 for details).

Another quite different way in which Humean Supervenience has been rejected is by Armstrong (1999) (see also Dretske 1977; Tooley 1977), who upholds quidditism about fundamental properties but introduces primitive necessitation relations between universals to account for laws. On this account, laws of the form "all Fs are Gs" are analysed in terms of a necessitation relation, *N*, which in this case holds between the universals F and G. The fact that the higher-order universal, *N*, connects the universals F and G is what makes it a *law* that all Fs are Gs, on this account.

In each case, giving up Humean Supervenience is closely connected to the provision of a non-Humean account of laws. DE accounts for the laws in terms of the essences of properties that *contain* those laws and the Nomic Necessitation view accounts for the laws in terms of primitive, higher order, necessary connections between universals.

Among the positions outlined, two broad conceptions of natural law have been employed: a *governance* conception and a *codification* conception. Armstrong's Nomic Necessitation view is a governance conception. It conceives of the laws – *N's* – as imposed "pushers and pullers" of the *stuff* in the world. In the previous chapter, certain similarities between DE and the Armstrongian view were noted. In particular, it was shown that the dispositional essentialist's M-relations play the same governing role as Armstrong's *N's*, which is what made DE vulnerable to the very issue that Bird (2005) raises for Armstrong's view (see Barker and Smart 2012). Where *N's* are external to the properties that they govern, M-relations are internal to properties because they constitute the real essences of those properties, but this does nothing to change the fact that M-relations govern. Furthermore, I argued, in chapter 3, that M-relations just *are* the dispositional essentialist's laws. Hence, DE is plausibly interpreted as a governance conception. The BSA, by contrast, conceives of the laws as merely describing or codifying matters of fact. The laws, according to the BSA, have no prescriptive power over events, rather they describe, in a particularly efficient way, what goes on in the universe.

4.3 A Concern About Motivation

To uphold the thesis of Humean Supervenience is to maintain that *everything* supervenes on the arrangement of point-sized instances of categorical properties and the spatiotemporal relations between them. Within the scope of "everything" in the previous sentence are facts about the laws of nature. The BSA is plausibly understood as Lewis's attempt to reconcile the appearance of necessity in nature, in the form of natural laws, with the claim that all facts, including those about laws, supervene on a sparse base that is absent any necessary connections or primitively modal properties. Lewis develops Ramsey's idea that the laws are: "consequences of those propositions which we should take as axioms if we knew *everything* and organised it as simply as possible in a deductive system" (Ramsey 1990, 150, my emphasis). Lewis modifies Ramsey by replacing "everything" with "as much of everything as admits of simple organization", otherwise everything would count as a law (Lewis 1994, 478). The crucial idea is that, according to the BSA, the laws take

into account facts about the mosaic considered collectively so that they may *describe* it in a way that best balances the virtues of simplicity and informativeness.

If, however, one were to admit primitive modalities into one's ontology, then it might seem unclear why one would, or indeed how one *could*, also defend a *Humean* account of laws, such as the BSA. We might distinguish two strands to this motivation concern:

i) Why *bother* with the BSA if we are happy to admit primitive necessary connections, which seem capable of doing the work of accounting for laws?

ii) Why think that the laws should form parts of an *integrated* systematization of the mosaic once primitive modalities are admitted?

Regarding i), the objector I have in mind here is one with the intuition that laws *govern*, as opposed to codify, matters of fact in the universe. That this is a relatively widespread intuition is evidenced in Beebee's (2000) survey of certain critiques of the BSA, which she argues miss the mark for failure to understand that the BSA is a *non*-governance conception of law. Furthermore, Mumford (2004) takes the lack of a governance role for laws as evidence for the claim that there are no laws.

The Nomic Necessitation view of Armstrong is a paradigm governance view of laws. Armstrong sacrifices Humean Supervenience and provides the laws with a governing role by introducing necessitation relations between universals. Now if one were of the belief that the laws govern, then it might seem odd to happily admit unHumean *whatnots* (to use Lewis's phrase) but not the right *whatnots* to yield a governing role for laws. In other words, the proponent of governance might wonder why, if we gladly surrender Humean Supervenience, we wouldn't include in our ontology (something akin to) Armstrongian "pushers and pullers" to account for the laws. Now this would constitute significant departure from the BSA, which is a codification conception, but the motivation concern is a challenge to say why or how we should preserve the essence of the BSA given an unHumean ontology.

The thought behind ii) is that once irreducibly modal properties are admitted, there would be no need (or scope) to think of the laws as forming parts of an *integrated* system because they would follow from particular property instances considered in *isolation* from the rest of the universe. Recall that DE gives up Humean Supervenience by admitting basic properties, whose essences are constituted by laws. What this means is that there need be no more than a single instance at a world, *w*, of a property, P, whose essence is constituted by the law, L, for it to be the case that L prevails at *w.* Armstrong, on the other hand, gives up Humean Supervenience with the introduction of necessitation relations between universals. An account of laws is then given in terms of *these* unHumean whatnots according to which if it is a law that all Fs are Gs then there is a higher order universal that *connects* the Fs and the Gs, i.e., which makes it the case that if something is F, then it is G also. But again, the unHumean elements of the ontology are capable of accounting for the laws independently of much else of what goes on in the universe. The necessitation relations, the *N*s, considered in isolation suffice to account for the laws.

On both the Dispositional Essentialist and the Nomic Necessitation account, the unHumean elements of the ontology suffice to account for the laws independently of vast swathes of the mosaic. The laws, on these accounts, are thus not *integrated* in the BSA sense.

The motivation concern for an account of Humean laws in an unHumean world is a challenge to say how we might understand the laws such that they form an *integrated description* of the unHumean mosaic such that the view may be deserving of the name "BSA". To allay the concerns expressed in i) and ii), I suggest that a *Humean* account of laws ought to satisfy the following desiderata:

> **C**(odification): The laws should be understood as descriptive, not prescriptive.
>
> **I**(ntegration): The laws should form an integrated systematization of the *mosaic* in the sense that *as much of everything as admits of simple*

organization should be relevant to any given law's status as a law.

Any account of laws that failed to satisfy **C** and **I** would not really deserve the name "BSA" because it would stray too far from the letter of Lewis's development of Ramsey's idea that the laws are: "consequences of those propositions which we should take as axioms if we knew *everything* and organised it as simply as possible in a deductive system" (Ramsey 1990, 150, my emphasis).

It's all well and good to say that in order to deserve the name "BSA" an account of laws should satisfy **C** and **I**, but what, one might wonder, is so worthy about the BSA in the first place? Well, the BSA would seem to comport with actual scientific practice of devising strong and simple formulas, which are able to predict or accommodate a wide range of phenomena (see Demarest 2017, 40). In Cohen and Callender's words: "[The BSA] states that laws are generalizations that result from a trade-off between the competing virtues of simplicity and informativeness. Scientists certainly see themselves as engaged in the project of finding such generalizations" (2009, 3). Another way of putting this thought is that there seems to be a certain pragmatic element to the laws' status as such. It is those true descriptions of the workings of nature that are particularly general in their application and useful to *us* in our scientific and practical endeavours that are elevated to the status of *law*. The BSA, by conceiving of the laws as informative yet simple *integrated* descriptions or *codifications* of various patterns in nature, accommodates these sentiments.

Dispositional essentialism, on the other hand, by conceiving of laws as M-relations does little to recognise that laws are those generalizations that are useful to us in our scientific and practical endeavours. It is likely that there are many M-relations, which are highly specific and limited in scope and these will be next to useless for us insofar as we are interested in making predictions and manipulating our environment to serve our practical and scientific interests. To elevate all M-relations to the status of law would thus seem to just fail to recognise that laws are tools of *science*, which is concerned with devising strong and simple formulas, which are able to predict or accommodate a *wide range* of phenomena.

Furthermore, desideratum **I** is relevant to the concern, raised against DE, with simply building laws into the essences of those properties that are supposed to explain those very laws. Building laws into property essences is antithetical to **I** because if, as per DE, the essence of some property, P, is constituted by a law, L, then no more than a single instance of P at a world *w* is required for it to be the case that L prevails at *w*. Conversely, then, respect for **I** precludes this strategy of simply building laws into property essences and thus perhaps constitutes a constraint on a more *explanatory* account of laws in terms of properties – at the very least, respect for **I** precludes one *unsatisfactory* metaphysical explanation of laws in terms of properties because it precludes DE.

Thus, satisfaction of **C** and **I** is important not *merely* insofar as one wants one's account of laws to be deserving of a name. Satisfaction of **C** and **I** is also valuable insofar as we are interested in making sure that our philosophical account of laws concurs with scientific practice and that it avoids certain pitfalls to which the *dispositional essentialist's* attempt to explain laws in terms of properties succumbs.

I'll talk more about satisfying the desiderata in section 4.5, but as a prelude I turn to a discussion of Heather Demarest's Potency-BSA, which shall form the basis for my Revised Potency-BSA. It might appear that my work has been done by Demarest. I'll argue, however, that Demarest's account requires modification because it risks rendering the laws completely epistemically inaccessible. With the additional details of my Revised Potency-BSA I'll be able to overcome the concern raised for Demarest and I'll be in a better position to say in more detail how the desiderata identified above can be satisfied.

4.4 Demarest's Potency-BSA

Demarest posits an unHumean ontology of *potencies*, and she follows Bird's definition of a potency as "A fundamental, sparse property with a dispositional essence"(Bird 2007, 45). Demarest elaborates on Bird's definition accordingly: "The dispositional essence of a potency is the necessary connection between the property and the behaviour of objects that instantiate it" (2017, 46). Although I have argued

in detail against Bird's structuralist metaphysics of potencies (and the associated dispositional essentialist account of laws), I can agree with Demarest that there is a necessary connection between potencies and the behaviours of those objects which instantiate them. It is important to keep in mind, however, that on my view the necessary connection between potencies and behaviours does not hold because laws or dispositions *constitute* the essences of potencies (as the structuralist would have it). Rather, on the view I favour (QDE), potencies are qualitative *grounds* of these behaviours, and the grounding relation implies a necessary connection between potencies and the behaviours that they ground. But this disagreement about *how* the necessary connection between potencies and behaviours comes about is inconsequential to Demarest's account of laws; all that is important to that account is *that* such a necessary connection obtains. To be clear, then, I'll follow Demarest in using the term "potency" to refer to *fundamental*, or at least suitably low-level, properties, such as *charge*, *mass* and *spin*, which are necessarily connected to the behaviours of their bearers. Though keep in mind that this necessary connection comes about, on my view, because potencies are qualitative *grounds* of these behaviours, as per QDE.

Central to Demarest's Potency-BSA is the idea that the laws at a world, w, systematize (*à la* the BSA) actual and *possible* distributions of those potencies instantiated at w:

> **Potency-BSA:** The basic laws of nature at w are the axioms of the simplest, most informative, true systematization of all w-potency-distributions, where a w-potency-distribution is a possible distribution of only potencies appearing in w. (Demarest 2017, 49).

Demarest argues that systematizing *possible* potency distributions constitutes no additional cost because we have already admitted primitively modal properties into our ontology (2017, 49) and that by systematizing other relevant possibilities, the Potency-BSA avoids the *impoverished world objection*.

According to the impoverished world objection, the traditional BSA yields counterintuitive results about the laws of nature at "impoverished" worlds. The objection considers a world, call it *I*, whose sole inhabitant is a single massive particle travelling inertially for all time. Now according to the BSA, it is a *law* at *I* that all massive particles always travel inertially. But this seems wrong, so the objection goes, because we think that it is *not* a law that all massive particles always travel inertially at the impoverished world because *if* there were a second massive particle, then the two would accelerate towards each other.

Setting aside concerns about how convincing or otherwise the impoverished world objection is; I note for now just that *one* of the reasons Demarest offers in favour of her Potency-BSA is that it provides a response to this objection. Furthermore, the details of Demarest's response shed additional light on her view:

> Consider, again, a world with a single massive particle, traveling inertially for all time. The laws of this world will systematize not just this world, but all worlds that contain mass. Therefore, it will be a law that all massive particles attract each other, and NOT that they always travel inertially. (2017, 51).

Inhabitants of an impoverished world would be unable to *arrive* at a correct account of the laws because they would be in a kind of sceptical scenario. Similarly, if our world turned out to be impoverished, we too would be in a sceptical scenario and so unable to know the laws. But this is acceptable, Demarest suggests, because there should be no guarantee that the laws are epistemically accessible. I argue, however, that the Potency-BSA faces a more pressing sceptical worry.

4.4.1 A Sceptical Worry

Call a world, *w**, *relevant* to the laws at a distinct world, *w*, iff some element of *w** partly determines *w*'s laws. Thus, if the distribution of, say, *mass* at a world *w1* is systematized by the laws of *w2* because *mass* is instantiated at both, then *w1* is relevant to the laws at *w2*.

To see the sceptical worry, we must consider *which* worlds Demarest's Potency-BSA deems relevant to the laws at a given world. Consider a simple world, *w0*, at which just *mass* and *charge* are instantiated. We can denote the situation like this: *w0*(mass, charge). According to the Potency-BSA, the laws of *w0* systematize all *w0*-potency distributions, where a *w0*-potency distribution is a possible distribution of only potencies appearing in *w0* (Demarest 2017, 49). The laws of *w0* are thus partly determined by the distributions of *mass* and *charge* at worlds besides *w0*. Hence, worlds besides *w0* are *relevant* to *w0*'s laws. For all that has been said, we can discern *four* options for the range of worlds relevant to the laws of *w0*(mass, charge):

Option 1: worlds with ALL the potencies found at *w0*. This would include worlds with some potencies *alien* to *w0* and would omit worlds lacking potencies instantiated at *w0*. For example, *w1* would be included *w1*(mass, charge, schmass), but not *w2*(mass).

Option 2: Worlds with ONLY the potencies found at *w0*. This would rule out worlds with alien potencies and include worlds absent some potencies instantiated at *w0*. For example, *w2* would be included, but not *w1*.

Option 3: Worlds with ALL AND ONLY those potencies found at *w0*. This rules out worlds with potencies that are alien to *w0* and worlds absent any potencies instantiated at *w0*. For example, *w3* (which has the same potency instances as *w*, though those potency instances might be differently distributed) would be included *w3*(mass, charge), but *w2* and *w1* would not.

Option 4: Worlds with SOME of those potencies found at *w0*. This just rules out worlds that are absent all of the potencies instantiated at *w0*. For example, *w1*, *w2* and *w3* would be included, but not *w4*(schmass, schmarge).

I suggest that Demarest may be interpreted as endorsing either option 2 or option 4. Option 4 seems to follow from Demarest's explicit statement of the Potency-BSA (2017, 49) as well as perhaps from her response to the impoverished world objection (2017, 51). Saddling Demarest with option 4, however, might seem less charitable, since radical scepticism about the laws quickly follows from this option. Hence, the Potency-BSA could at least benefit from clearer articulation to avoid this interpretation. As it happens, however, option 2 also faces a sceptical

worry via a subtler route. I'll discuss these different interpretations (and the sceptical threat to each) in turn before proposing a revision to the Potency-BSA that avoids these problems and satisfies the desiderata identified in section 3.

Demarest is clear that the laws of a world, *w*, are unconcerned with possible distributions of potencies *alien* to *w*: "The basic laws of nature at *w* are the axioms of the simplest, most informative, true systematization of all *w*-potency-distributions, where a *w*-potency-distribution is *a possible distribution of only potencies appearing in w*." (ibid, my emphasis). However, we cannot infer from this that only those worlds containing just the same potencies as *w0*(mass, charge) are relevant to *w0*'s laws because among the possible distributions of *mass* are those distributions of mass at worlds where, e.g., *schmarge* is instantiated too.

Moreover, consider Demarest's response to the impoverished world objection: "Consider, again, a world with a single massive particle, traveling inertially for all time. *The laws of this world will systematize not just this world, but all worlds that contain mass*." (ibid, my emphasis). Relative to the impoverished world, potencies found at the actual world; charge, spin, etc. are alien, but Demarest seems to imply that the laws at the impoverished world nonetheless concern the distribution of mass at the actual world because "The laws of this world will systematize…all worlds that contain mass" and the actual world contains mass. On this reading, it seems that for Demarest all worlds with at least *some* of the potencies found at a world, *w*, are relevant to the *laws* at *w*, which is option 4.

Scepticism about the laws quickly follows because inhabitants of *w0*(mass, charge) could not possibly know how *alien* potencies, like *schmass*, would affect the distribution of *w0*-potencies, namely *mass* and *charge*, so they couldn't possibly come to know all *w0*-potency-distributions, the best systematization of which determines the *laws* at *w0*. The problem generalizes and makes the actual laws unknowable too. In essence, the problem is this: at worlds with alien potencies, familiar potencies, like *mass* and *charge*, might behave very differently. We cannot know how alien potencies will affect the distribution of, e.g., *mass* and *charge*, so if the actual laws concerning *mass* and *charge* are supposed to systematize their distributions in the presence of alien potencies, we cannot know the laws. It is

plausible, however, that we possess all sorts of knowledge about natural laws, or are at least capable in theory of acquiring such knowledge, so we are justified in rejecting any metaphysical view that would imply otherwise.

Alternatively, we might interpret Demarest's definition of a *w*-potency distribution: "a possible distribution of only potencies appearing in *w*", to mean a distribution of *all* the potencies at some possible world, *w**, where the only potencies found at *w** are potencies that are also found at *w*. On this reading, the distribution of *mass* at a world containing *schmass* would not be a *w0*-potency distribution, where *w0*(mass, charge). But distributions of *mass* at worlds with just *mass*, for example, as well as other possible distributions of *mass* and *charge* at worlds with no other potencies besides, would count as *w0*-potency distributions. On this interpretation, Demarest goes for option 2. Accordingly, when Demarest writes, regarding the impoverished world: "The laws of this world will systematize…all worlds that contain mass", she must be read as speaking elliptically for "all worlds that contain only mass".[17] If this were the intended interpretation, I'd suggest the following modification to the definition of the Potency-BSA:

> **Potency-BSA*:** The basic laws of nature at *w* are the axioms of the simplest, most informative, true systematization of all *w*-potency-distributions, where a *w*-potency-distribution is the distribution of all the potencies at a world, *w**, where *w** contains no potencies alien to *w*.

However, just as, for all we know, the distribution of *mass* might be radically unfamiliar at worlds where *schmarge* is instantiated, for all we know, the distribution of *mass* might be radically unfamiliar at worlds *absent*, say, *charge*. We inhabit a world where both *mass* and *charge* are instantiated (as well as other potencies) and in our world *mass* is distributed as it is and we can make certain inferences about the possible distributions of *mass*. What we cannot know, I suggest, is how the absence of *charge* at a world would affect the behaviour of masses and

[17] Thanks to an anonymous reviewer at the *Journal of the American Philosophical Association* for suggesting this.

this imposes a restriction on the range of possible *mass* distributions that we are able to know.

This concern is driven, in part, by reflection on the apparent *fine-tuned-ness* of the universe. It is often suggested that had certain fundamental physical constants been even slightly different, a radically different universe would have resulted; one without any carbon-based life or even any coalesced matter, perhaps:

> …if the strength of gravity were smaller or larger by an estimated one part in 10^{60} of its current value, the universe would have either exploded too quickly for galaxies and stars to form, or collapsed back on itself too quickly for life to evolve. (Collins 2009, 215)

> Had the boundary conditions in the initial seconds of the big bang, and the values of various fundamental constants differed ever so slightly we would not have had anything like a stable universe in which life could evolve. (White 2001, 260)

But if minor tweaks to physical constants would result in such a radically different universe, it seems plausible that a *big* change – the omission of a ubiquitous fundamental potency, such as *charge* – might result in a world that is utterly unrecognizable. These considerations might reasonably inspire a distinct lack of confidence in our ability to *know* much at all about what such worlds would be like, including with respect to, say, how *mass* is distributed. Better, then, not to allow those likely *unknowable* possible distributions of *mass* in such radically different worlds to be relevant to the actual laws.

One might respond that given the success science has enjoyed when it comes to isolating potencies from each other, we *can* be confident in our ability to make inferences about the possible behaviour of, say, massive bodies in the absence of charges. But, besides the physical implausibility of the idea that we might completely isolate mass from charge, we cannot ever make it the case that *mass* is instantiated in a *world* where *charge* is uninstantiated and that we are there to

observe the results. The sceptical concern is not that masses might behave oddly when isolated under lab conditions from the effects of *charge* at a world in which *charge* is nonetheless instantiated. The worry is that masses might behave oddly when instantiated in a world at which *charge* is *nowhere* instantiated – call this an *S*-type hypothesis. No lab can create these conditions; we are all world-bound.

There may be a temptation to dismiss *S*-type hypotheses as no more problematic than run-of-the-mill external world scepticism.[18] However, *S*-type hypotheses are of a very different kind to run-of-the-mill sceptical hypotheses. A typical run-of-the-mill sceptical attack on knowledge argues that since I cannot know I am not a brain-in-a-vat (BIV), I cannot know all sorts of things about the *actual world*, like that I have hands, because having hands is inconsistent with being a BIV. *S*-type hypotheses, by contrast, do not threaten our knowledge of the actual world; they threaten our *modal* knowledge. The fact that I cannot rule out the hypothesis that *mass* is distributed very strangely in worlds absent *charge* limits what I can know about other possible worlds. Furthermore, reflection on the apparent fine-tuned-ness of the universe provides *S*-type hypotheses with at least some *prima facie* plausibility not enjoyed by, say, the run-of-the-mill sceptical hypothesis that I am a BIV.

Given these differences, one would not necessarily expect responses to run-of-the-mill scepticism to be effective against the sceptical threat posed by *S*-type hypotheses. Consider, for example, a typical externalist response to run-of-the-mill scepticism (e.g., Nozick, 1981), according to which a belief counts as knowledge just in case it is true and it tracks the truth at nearby worlds. Assume that I inhabit the actual, non-BIV-world and that I have a true belief that that I have hands. This belief counts as *knowledge* because in nearby worlds in which I am handless (perhaps due to some unfortunate accident) I do not believe that I have hands and in nearby worlds where I do have hands I believe that I do. Sure, my belief would fail to track the truth at the BIV-world, but knowledge does not require truth-tracking at such *distant* worlds, on this account. This type of response justifies the dismissal of run-of-the-mill sceptical hypotheses by showing them to be *compatible* with much of our

[18] Thanks to an anonymous reviewer at the *Journal of the American Philosophical Association* for raising this.

knowledge, as well as emphasizing the fact that run-of-the-mill sceptical hypotheses themselves enjoy no *prima facie* plausibility for being so *distant.*

No such response is available to the threat posed by *S*-type hypotheses. It is consistent with my having hands that, say, *mass* is distributed very strangely in worlds absent *charge*. It thus does nothing to quell the sceptical threat of *S*-type hypotheses to show that everyday knowledge of the actual world is consistent with our inability to rule them out. Furthermore, and as mentioned above, *S*-type hypotheses enjoy at least some *prima facie* plausibility once we reflect on the fine-tuned-ness of the universe. Unfortunately, it would lead me too far astray to survey all possible responses to run-of-the-mill scepticism. But plausibly the point will extend to other responses given the very different kind of threat posed by *S*-type hypotheses compared with that posed by run-of-the-mill sceptical hypotheses as well as the fact that the former, but not the latter, enjoy at least some *prima facie* plausibility. I thus take these considerations to show that *S*-type hypotheses should not be immediately dismissed as on a par with run-of-the-mill scepticism.

On the other hand, it might be argued that the scepticism ushered in by *S*-type hypotheses, if accepted, proves too much; for ought we not also to think that we cannot know how *mass* would behave in a world absent, say, Bill Clinton (BC)?[19] The obvious response is that we have lots of evidence to suggest that the distribution of *mass* is completely independent of BC and hence it seems reasonable to infer that the distribution of mass would be unaffected by his absence. Of course, we cannot rule out the logical possibility that BC's existence plays some key role in the law concerning *mass*, but this hypothesis deserves being taken no more seriously than *Russell's Teapot*.

So why not employ a similar answer when *charge* is substituted for BC? (Of course, to do so would undermine my argument above). Well, I note first there is a weak sense in which BC *is* relevant to the law concerning *mass*. Insofar as BC is composed of massive particles, he is relevant to the overall cross-world distribution of *mass* and hence the mass-law. But BC's negligible contribution to the distribution of *mass* is plausibly far from pivotal to the *robustly* best system of which the law

[19] Thanks to an anonymous reviewer at the *Journal of the American Philosophical Association* for raising this.

concerning *mass* is an axiom. But whereas worlds absent BC would differ negligibly from the actual world, worlds absent any instances of *charge* whatsoever would be radically different from actuality. It at least seems plausible that in such a radically different world, the distribution of *mass* would be significantly affected and it is this *prima facie* plausibility that is lacking in the cases of hypotheses about BC and *Russell's Teapot*. *Charge* is a ubiquitous, *fundamental*, potency. The concern is really that the possible distributions of ubiquitous fundamental potencies might be more tightly entwined than we could ever know. It would be a quite different matter to claim that any individual whatsoever might have some crucial, yet unobservable, impact on the possible evolution of the universe. BC is not a ubiquitous fundamental potency and so cannot be substituted for "*charge*" in, for example, the hypothesis that we cannot know how *mass* would behave in a world absent *charge* without significantly altering the claim.

I thus suggest that we go for option 3, which avoids the sceptical problems by rendering only those worlds instantiating all and only the potencies instantiated at *w* relevant to *w*'s laws. But if, for all that has been said, you remain unconvinced, I offer one final consideration in favour of this option. Either *S*-type hypotheses pose no sceptical threat, for whatever reason, so we can embrace option 2: worlds with ONLY those potencies found at *w* are relevant to *w*'s laws. Or *S*-type hypotheses are a threat and so to ensure the epistemic accessibility of the laws we should go for option 3: worlds with ALL AND ONLY those potencies found at *w* are relevant to *w*'s laws. In a *Pascal's Wager*-type move, I suggest that unless we can be completely certain that *S*-type hypotheses pose absolutely no threat, we should go for option 3. This is because we stand to lose relatively little, perhaps even nothing, by choosing option 3 over option 2 – maybe the laws of a world, *w*, will be slightly less informative than they might have been because they will systematize fewer possibilities. If, on the other hand, we go for option 2 and it turns out that *S*-type hypotheses are problematic in the way described, we lose all epistemic access to the laws (which would plausibly count as *infinitely* bad in the context of an analysis of laws!). We cannot be absolutely certain that *S*-type hypotheses pose no

threat whatsoever, we can only have perhaps a relatively high degree of *confidence* that they are unthreatening, so option 3 is best.

In the next section I suggest a revision to the Potency-BSA, which guarantees to avoid scepticism about the laws and which, as I shall argue in 4.5.1, can satisfy the desiderata set out in section 3.

4.5 The Revised Potency-BSA

Demarest's Potency-BSA makes the innovative leap of systematizing a range of possible worlds. The sceptical concern arises, however, because *too many* worlds are systematized. My suggestion is thus to systematize *fewer* worlds.

Of the four options for the range of worlds we deem relevant to the laws at a given world, w, I suggest option 3: just those worlds at which all and only the potencies instantiated at w are instantiated. I hence propose the following:

> **Revised Potency-BSA:** The basic laws of nature at w are the axioms of the simplest, most informative, true systematization of all w-potency-distributions, where a w-potency-distribution is a distribution of only potencies appearing in w at a world instantiating all and only those potencies instantiated at w**.**

By truncating the range of worlds deemed relevant to the laws at a given world, w, in this way, the sceptical concern is avoided. We cannot know how actual potencies, like *charge*, will be distributed in worlds instantiating alien potencies, or how they will be distributed in worlds that are absent actual potencies, but according to the Revised Potency-BSA such possibilities are irrelevant to the actual law concerning *charge.*

4.5.1 Modal Profiles and Satisfying the Desiderata

We might say that the laws at w, according to the Revised Potency-BSA, are a function of the *modal profiles* of all and only the potencies instantiated at w. Up until now, I have been using the term "modal profile" somewhat loosely to refer to the

full range of behaviours or dispositions with which a potency is associated, or which a potency *grounds*, and, hence, with which a potency is necessarily connected. In this subsection I shall present a more formal definition of "modal profile", which will help me to show exactly how the Revised Potency-BSA can satisfy the desiderata outlined in section 4.3.

The modal profile of a potency, *P*, is the range of properties with which *P* is possibly *coinstantiated* by a property-bearer. In possible worlds talk, the modal profile of *P* will specify, for any property *X*, if there is a world, *w*, at which some individual, *x*, instantiates *P* and *X*. Since we aren't specifying that *X* is fundamental or *sparse* – *X* could stand for a conjunctive property – we capture the idea that the modal profile of *P* has to do with possible *combinations* of properties with which *P* is coinstantiated by a property-bearer. Furthermore, since we are not ruling out that the *X*s with which *P* is possibly coinstantiated in virtue of *P*'s modal profile are *extrinsic* properties – they might be relational – we capture that *P*'s modal profile determines how instances of *P* might possibly be *distributed* in space and time. A particular brick, for example, might coinstantiate *toughness* and *redness*, but the brick might also instantiate such extrinsic properties as *being in a wheelbarrow* or *forming part of the foundations of a house*. We might say that the property *toughness* is possibly coinstantiated with the extrinsic property *forming the foundations of a house*. The modal profile of the property *toughness* allows for such possibilities. Similarly, the potency *electric charge*, in virtue if *its* modal profile, is possibly coinstantiated with the property of *partially constituting an atom of carbon* – electrons, for example, instantiate electric charge and can also instantiate the extrinsic property of *partially constituting an atom of carbon.*

Talk of the *behaviours* or *dispositions* that a potency grounds and, hence, with which it is necessarily connected, is imprecise and can be substituted for the more precise notion of a modal profile. Potencies, then, are necessarily connected with their modal profiles, that is, with the range of properties (including complex and extrinsic properties) that their bearers *possibly* instantiate. And this, on my view, is because potencies *ground* their modal profiles.

The laws at *w* are thus a *function* of the modal profiles of all and only those potencies instantiated at *w*, according to the Revised Potency-BSA. The laws are efficient summaries of the facts about possible distributions of those potency instances, where the possible distributions of potencies at *w* are determined by those potencies' modal profiles. We can understand what it is for a potency to figure in some *distribution* in terms of the properties, including extrinsic properties, with which it is coinstantiated. For a given world, *w*, we thus have a hierarchical grounding structure at the base of which we find the potencies, which ground their *modal profiles.* These modal profiles then ground the possible distributions of the *w*-potency instances, which in turn ground the laws because the *w*-laws are summaries of the possible distributions of the *w*-potency instances that best balance the virtues of informativeness and simplicity.

We are now able to say more precisely how the Revised Potency-BSA satisfies desideratum **C**. Given a world of potencies, fully capable of "pushing and pulling" things around, or *determining their own distributions*, in accordance with their *modal profiles*, we would seem to have no need for additional governing laws. The Revised Potency-BSA satisfies **C** because it says that the laws at *w* are the axioms of the system that best balances the virtues of informativeness and simplicity in its effort to convey all of the information about the distributions of the *w*-potencies in all possible worlds at which all and only *w*-potencies are instantiated. The potencies themselves might be thought to do some "pushing and pulling" because they metaphysically *determine* their possible distributions in accordance with their modal profiles, but the potencies are not laws, the laws are features of a *description* of the possible distributions of those potencies that best balances the virtues of informativeness and simplicity.

The tougher task faced by any account of Humean laws in an unHumean world is that of satisfying **I**. Recall that according to Dispositional Essentialism, desideratum **I** is not satisfied because laws constitute potency essences which means that a single instance of a potency, *P*, at a world, *w*, suffices for the law, *L*, associated with *P* to hold at *w*. Particular laws, according to Dispositional Essentialism, hold independently of vast swathes of the fundamental mosaic of

potencies at a world. QDE does not automatically satisfy **I** either, for if particular potency instances fully grounded laws, then again, the laws would hold independently of much of what went on at a world and hence would not be *integrated*.

In order to satisfy desideratum **I**, the Revised Potency-BSA must understand the laws *not* as codifying the essences of particular potencies considered in isolation, or otherwise as being true descriptions fully grounded in particular potency instances. Rather, the laws must be understood as codifying the possible *distributions* of all potency instances considered collectively. As we have seen, it is the potencies' *modal profiles* that carry implications for their possible distributions; a given potency, by its very nature, grounds its modal profile, which in turn determines the range of properties with which that potency is possibly coinstantiated, including the distributions in which it can (metaphysically possibly) feature. So, talking in terms of modal profiles facilitates discussion of the present account of laws according to which the *w*-laws are parts of an efficient integrated description of the possible arrangements of the *w*-potencies.

Crucially, the possible distributions of *w*-potencies across worlds instantiating all and only the *w*-potencies will have to do with the *w*-potencies considered *collectively*. The distribution of *w*-potencies across possible worlds will be determined by the various possible *interactions* between potency instances. We can illustrate the thought with a macroscopic example. Consider a vase encased in formaldehyde. Among the possible distributions of the stuff in a world, *w*1, that included vases and formaldehyde, there might be very few possibilities in which a vase encased in formaldehyde at one time, $t_{earlier}$, is then shattered at a later time, t_{later}, but in which there is no time between $t_{earlier}$ and t_{later} at which the vase is not encased in formaldehyde. Put more simply, the point is that the possible *interaction* between the vase and the formaldehyde restricts how those things could possibly be distributed in space and time. In very few possibilities does an unbroken vase become broken in a timespan in which it is encased in formaldehyde. Plausibly, potencies, such as *charge*, *mass*, *spin*, etc. will exhibit analogous interactions. The *w*-laws of the Revised Potency-BSA thus respect desideratum **I** by summarising all the

information about possible configurations of *w*-potency instances in a manner that accounts for the various possible interactions between the *w*-potencies. To best capture this information, we need to "zoom out", so to speak, so that we may understand how the various potencies at a world, with their modal profiles, can possibly interact. No potency, or indeed cluster of potencies, considered in isolation from the entire distribution of potencies at a world could suffice to ground the laws, on this conception, hence **I** is satisfied.

4.5.2 Ceteris Paribus Laws

I have said that potency instances will interact in various ways, determined by their modal profiles. One way in which potencies might interact is by *masking* each other. The modal profile of the potency *charge* is such that distinct instances of charge can exert a force on each other. But this ability to exert a force conferred on an instance of charge, *e*, might be masked if extrinsic factors conspire to make it the case that *e* never manifests this ability. This is analogous to the way in which wrapping a vase in bubble wrap *masks* its disposition to break.

It would seem to follow that there is at least one possible world at which all and only those potencies instantiated at the actual world are instantiated, and in which the instances of charge have their ability to exert a force on other instances of charge in accordance with Coulomb's consistently masked. In this world, it so happens that distinct instances of charge never instantiate the property of exerting a force on each other in accordance with Coulomb's law because something always *gets in the way*, so to speak.

Why then, we might wonder, should Coulomb's law be an *axiom* of the best systematization of the possible distributions of all and only the potencies at the actual world? The answer comes, I suggest, from reflection on the *ceteris paribus* nature of laws. It is implicit in the formulation of Coulomb's law (and other laws) that intervening factors are absent. All Coulomb's law says *explicitly* is that separated charges exert a force on each other proportional to the magnitude of their charge and inversely proportional to the square of the distance between them. What is left *implicit* is that this is only the case in the absence of, say, a nearby black hole,

or indeed anything else that may negate the tendency of charged individuals to interact in accordance with Coulomb's law. What Coulomb's law tells us, on the current conception, is that in the absence of intervening factors, i.e. *ceteris paribus*, charged bodies will interact thusly and so-ly. Coulomb's law so conceived seems like a good candidate for entering into a strong, simple systematization of the possible distribution of all and only the potencies in the actual world and hence a good candidate for a *law* even given its *ceteris paribus* nature. Indeed, it really should count as a *benefit* of the present account that it accommodates the *ceteris paribus* nature of the natural laws.

The laws, on this account, form parts of an *integrated description* of possible potency arrangements; desiderata **C** and **I** are satisfied. No potency instance considered in isolation can suffice to ground any law because the laws at a world, *w*, are the axioms of the best systematization of the possible interactions *between* the totality of potency instances at *w*. Possible arrangements of all and only the potencies at *w*, which are *systematized* as part of the Revised Potency-BSA, depend on no potency instances considered in isolation, but rather on the potency instances at *w* considered *collectively*.

4.5.3 Why *This* Combination of Views?

Over the course of this chapter and the last, I have presented and defended the combination of QDE as a metaphysics of properties and the Revised Potency-BSA as a metaphysics of laws of nature. This was in large part motivated by the problems with the Dispositional Essentialist's strategy of building laws into property essences and the associated *structuralist* metaphysics of properties. Structuralism, it was shown, is subject to an explanatory regress, which casts doubt on its ability to explain the spatiotemporal distribution of properties in terms of the essences of those properties themselves. Furthermore, on the plausible assumption that the M-relations, that is, arcs in the structuralist's structure, just are the laws, according to DE, it seems that DE cannot non-circularly explain the laws in terms of potencies (see section 3.5). One might wonder, however, if the problems for the Dispositional Essentialist's package of views about laws and properties might be avoided by

either *just* giving up structuralism in favour of QDE and keeping the view of laws as M-relations, or *just* giving up the view of laws as M-relations in favour of something more like the BSA and keeping the structuralist metaphysics of properties. I'll briefly show in this subsection why the combination of QDE and the Revised Potency-BSA is preferable to either of these two options.

Consider first a view according to which potencies are qualities, as per QDE, which (asymmetrically) *ground* a structure of M-relations and where those M-relations just are the *laws*. This way, potencies need not be said to contain laws in their essences and, hence, laws and potencies are not symmetrically grounded in each other. The problem for Dispositional Essentialism's *explanatory* aims (raised in section 3.5) would thus seem to be avoided by *this* package of views. The problem, however, is that M-relations are not particularly good candidates for laws. The laws, it has been suggested (in section 4.3), should be strong, simple generalizations, which help to explain and predict a wide array of phenomena. Particular M-relations, however, are very specific and narrow in scope. Hence a philosophical account of laws as M-relations would not appear to be particularly consonant with actual scientific practice, which is concerned with strong, simple formulas with wide applicability. The Revised Potency-BSA does better on this score.

Alternatively, then, one might endorse structuralism as one's metaphysics of properties and (something akin to) the Revised Potency-BSA as one's metaphysics of laws. Perhaps this package can claim continuity with science and avoid the symmetrical grounding problem. For if laws were strong simple *descriptions* of the structure, as opposed to *arcs* in the structure, as M-relations are, then they would achieve the breadth of scope that *science-friendliness* would seem to demand. Furthermore, it would *not* seem to be the case that the laws, so understood, ground properties, because properties certainly do not ontologically depend upon *descriptions* of their actual and possible space-time distributions any more than anything ontologically depends on a description of itself. This package, however, does not remedy Barker and Smart's regress for structuralism, which simply said that properties, on the structuralist understanding, cannot metaphysically explain how they are distributed throughout space and time without engendering an

infinite regress or positing brute necessary connections. Barker and Smart's objection didn't target an account of *laws* in particular, it targeted the more basic claim to metaphysically explain the space-time distributions of properties in terms of the very essences of those properties. Regardless of what one takes the laws to be on the structuralist picture, one should find Barker and Smart's regress damaging to the structuralist's explanatory aspirations. One *could* advocate structuralism and the Revised Potency-BSA as an account of laws, but this would do nothing to address the question of just how it is that properties, according to structuralism, can metaphysically explain the space-time distributions that are supposed to ground the laws, according to the Revised Potency-BSA.

If one wants to respect scientific practice and if one wants to properly explain the space-time distributions of potencies, and hence the laws, in terms of the essences of the potencies themselves, then the best option is to combine QDE with the Revised Potency-BSA.

4.6 Chance

To further motivate my view, I want to consider how the Revised Potency-BSA might handle objective chance – a notorious stumbling block for the Humean laws-ontology package. In a nutshell, the problem is that the traditional BSA assigns non-trivial chances to futures that would undermine those very chances. Let's look in a little more detail at how this odd result arises before seeing how the Revised Potency-BSA might do better.

According to the *Humean* Best Systems analyst, facts about *chances*, like all other contingent facts, must be made true by some feature(s) of the Humean mosaic. What's more, by Lewis's Principal Principle (PP), which says that our credence in a proposition given the chance of that proposition and any *admissible* evidence ought to just equal the chance, these "chancemaking" features must be the sorts of things that, if known, could constrain rational credence (Lewis 1994). After considering, and dismissing, symmetries and frequencies as the fundamental chancemakers,[20]

[20] Symmetries can be defeated by frequencies but frequencies cannot account for single case chances of a unique kind, nor can finite frequencies yield irrational chances. (Lewis 1994)

Lewis suggests that single case chances follow from general probabilistic *laws of nature* (Lewis 1994, 478).

Just as "charged bodies exert a force on all other charged bodies" may be an axiom of the best system and hence a law, so might "tritium has a half-life of 12.3 years". The latter "law" is probabilistic in the sense that it implies, for any given tritium atom, that it will have a 50% chance of decaying in a 12.3-year time interval. Where previously the BSA was just concerned with trading off strength and simplicity, with the introduction of probabilistic laws comes a new criterion that must be balanced: fit. A systematization will fit a world, *w*, better to the extent that it assigns a higher chance to the entire history of *w*.

The BSA treatment of chance simply says that the chances are what the laws of the system that strikes the best balance between strength, simplicity and fit says they are. Assuming "tritium has a half-life of 12.3-years" is a law, given these criteria, it will also be true that a particular tritium atom has a 50% chance of decaying in a 12.3-year time interval and this fact will be made true by the Humean mosaic in the desired way.

Chances thus supervene on the entire 4-D mosaic of matters of particular fact, past, present *and future*. This means that different futures will determine different present chances. To see the "Bug", reconsider the law which says tritium has a 12.3-year half-life and the associated single case chances that this law projects. This probabilistic law and the single case chances projected are consistent with a future in which vastly more tritium atoms come into existence than have existed thus far (maybe due to some cataclysmic colliding of galaxies or something) where these atoms all decay in well under 12.3-years. In this case, the mosaic would make it true that the half-life of tritium is far *less* than 12.3-years. Now there is a sense in which this alternative future could come to pass: it is assigned a non-zero chance by the actual probabilistic laws, but in another sense it could not because its coming to pass would contradict the fact of the matter about present chances (Lewis 1994, 482).

This odd result can be shown to yield a flat contradiction if we consider again the Principal Principle (PP). PP says that our credence, Cr, in a proposition, A,

given the chance, x, of A and all admissible evidence, E, ought to just equal x, the *chance* of A.

$$\text{PP:} \qquad \text{Cr}(\text{A} \mid x \ \& \ \text{E}) = x$$

Now take A to be the alternative future history in which vastly more tritium atoms come into existence than have ever existed so far, each of which decays within, say, 5 years. And take E, our admissible evidence, to include the whole truth about the present actual chances. The present chance of this future obtaining, according to the best system, is > 0. So, by PP, our credence in this A ought to be > 0. However, we also know that this future is inconsistent with E, because if this future came about, our present chances would have been different than they actually are. And so it seems that our credence in A ought to be 0. Thus, we have a contradiction: (Cr>0) & (Cr=0).

Lewis offers a solution to the bug whereby he claims that admissibility admits of degrees, relative to the proposition our credence in which is at stake. He argues that in the above instance of PP, the evidence about the present actual chances is not fully admissible and hence the derivation of the contradiction is spurious (see Lewis 1994 for details). Even if one were convinced that this strategy successfully blocked the contradiction, the very fact of present chances undermining themselves remains, and this seems very strange indeed. So let's see if a potency-BSA can do any better.

4.6.1 Revised Potency-BSA Chances

The Revised Potency-BSA can account for non-trivial chances in much the same way as that suggested by Lewis: by showing them to follow from general probabilistic laws. But, as I'll show, the Revised Potency-BSA blocks the credence=0 side of the contradiction because it is consistent with the chances of a world, w, that the entire history of w diverges dramatically from what we would expect given those chances.

Consider again the distribution of tritium decay events throughout the actual world, @. Now, if we were to systematize all actual tritium decay events, we might find that close to 50% of tritium atoms decay within 12.3 years of coming into existence. Indeed, the traditional BSA might offer this sort of fact as part of an analysis of the probabilistic law according to which the half-life of tritium is 12.3-years – the candidate law will increase the *fit* of a system. But, as we've seen, this probabilistic law assigns non-zero chances to futures, which are such that the actual present chances would be different; the bug bites.

According to the Revised Potency-BSA, however, it is not enough to just systematize @. The laws of @ systematize tritium decay events across all worlds at which all and only those potencies instantiated at @ are instantiated. If, and only if, according to the *best* systematization of potency distributions across *all* relevant worlds, "tritium has a half-life of 12.3-years" is an axiom, then this fact will analyse relevant objective chances at @.

The bug doesn't bite this account. The @-law according to which tritium has a half-life of 12.3-years is consistent with an @-future in which vastly more tritium atoms than have ever existed previously come into being and all decay in well under 12.3-years – call this a recalcitrant future. It would not suffice to undermine the actual probabilistic law if a recalcitrant future were realized in @. This is because, according to the Revised Potency-BSA, the probabilistic law, which says that tritium has a 12.3-year half-life, is grounded in a relevant range of possible worlds and their entire histories. So, while in @ it may be turn out that most tritium atoms decay in well under 12.3-years, it can still be true that "tritium has a 12.3-year half-life" is an axiom of the best systematization of the potency distributions across *all* relevant worlds and hence a law at @. Since we cannot say that one's rational credence in a recalcitrant future coming to pass conditional on the relevant probabilistic law must be zero, the credence=0 side of the contradiction is blocked. We can consistently maintain that our credence in a recalcitrant future ought to be > 0.

One might, at this point, wonder about the criterion of *fit*. The Revised Potency-BSA presents the following picture: all possible worlds are split up into

equivalence classes under the relation "…contains all and only the same potencies as…". Hence, to each world, *w*, there corresponds one such equivalence class, the *w*-class. The laws of *w* are then the axioms of the best systematization of potency distributions across all worlds in the *w*-class. Until now I have said that the best such system is the one that strikes the optimal strength/simplicity trade off. But with the introduction of probabilistic laws, *fit* must be maximised too. Furthermore, just as strength and simplicity of competing systems are evaluated at the inter-world level, that is, we want the strongest, simplest systematization of potency distributions across *all w*-class worlds, so too should fit be evaluated at the inter-world level.

If fit were evaluated on a world-by-world basis, different systems would be best according to different *w*-class worlds, hence *w*-class worlds would differ with respect to their laws and chances and the bug would still bite.[21] Assuming that fit is to be evaluated on a world-by-world basis, consider two worlds in a given *w*-class, $w1$ and $w2$ and assume that $w1$ and $w2$ have different chances because different systems fit best in each case. Furthermore, assume that some initial segments of the histories of $w1$ and $w2$, H_{w1} and H_{w2}, match perfectly and that $w2$ contains finitely many chance events according to the laws of $w1$. Now let F be the proposition specifying the history of $w2$ after initial segment H_{w2}. As there are only finitely many chancy events occurring in F, the chance of F according to the laws of $w1$ is > 0. So, a subject in $w1$ whose evidence includes the $w1$-laws and hence the $w1$-chances ought to have a > 0 credence in F. But if F were to come to pass, the $w1$-chances would be different because, by hypothesis, $w2$, whose entire history is given by H_{w2}+F (where H_{w1} and H_{w2} match perfectly), has different chances to $w1$. So, we can *also* infer that the agent in $w1$ who knows the $w1$ chances should have 0 credence in F. The bug bites again. The salvage is to evaluate fit not on a world-by-world basis, but at the inter-world level such that all *w*-class worlds agree with respect to their laws and hence with respect to their chances.

How, then, are we to evaluate the fit of a system at the inter-world level? Sure, the law "tritium has a 12.3-year half-life" may fit the history of the actual

[21] Thanks to an anonymous reviewer at the *Journal of the American Philosophical Association* for raising this.

world, @, well, but there are many worlds in the @-class for which this law will be a very poor fit indeed. There may well be worlds in which all tritium atoms decay within a nanosecond and others in which no tritium atom decays in under a million years and everything else in between and more extreme. The hope must be that a system including the law "tritium has a 12.3-year half-life" fits the overall distribution of tritium decay events across all @-class worlds better than any competing system. It thus seems that we will need some weighting function over possible worlds. This is a problem faced by any account of chance in terms of possible worlds. What the Revised Potency-BSA does, then, is shift the problem of chances undermining themselves onto the problem of devising a weighting function over possible worlds. If one were more optimistic about our prospects of solving the latter problem, then this could be seen as progress, but I leave further treatment of this issue for elsewhere.

4.7 Doing Better than DE – Functional Laws and *Ceteris Paribus* Laws

In this chapter, I have defended a novel account of the laws of nature which combines an unHumean metaphysic of properties with a Humean account of laws as efficient descriptions of how those properties are possibly distributed. The Revised Potency-BSA respects desiderata **C** and **I** and so earns the "BSA" part of its name. But more importantly than this, respect for the desiderata promised an account of laws that is consonant with actual scientific practice and ensured that the laws are not simply built into the essences of potencies, as they are according to DE, and hence that one particularly unsatisfying and unexplanatory account of the relationship between laws and properties is avoided. DE's strategy of building laws into the essences of potencies is also related to two more specific problems, as argued in chapter 2. To conclude this chapter, then, I'll briefly discuss how neither functional laws, nor the ubiquity of *ceteris paribus* laws pose any particular problem for the package of QDE and the Revised Potency-BSA.

In section 2.3, it was shown that there can be no fundamental functional laws, according to DE. This is because not enough can be built in to the essence of a

potency, *P*, such that a functional law may be derived from a statement of *P*'s essence in accordance with DE's steps (I) – (V). Fundamental functional laws are not precluded by the Revised Potency-BSA. Fundamental laws, according to the Revised Potency-BSA are the *axioms* of the simplest, most informative, true systematization of all *w*-potency-distributions. Nothing in this definition of fundamental laws of nature implies that functional laws, which say how some quantities vary with each other, could not be fundamental. Indeed, it is eminently plausible that functions will feature as axioms of the true systematization of all *w*-potency distributions that best balances the virtues of simplicity and informativeness. Consider an imaginary functional law which says how the determinable quantities Q and R vary with one another. Surely this law would be far more tractable and useful to us than a (perhaps infinitely) long list of highly specific laws each of which tells us that some particular determinate value of Q goes with some determinate value of R. Functional laws, it seems, are well suited to presenting information about possible potency distributions in a way that is easily accessible *to us* and useful for our practical and scientific endeavours.

In section 2.4, I presented a concern for DE, due to Corry (2011), according to which the Cartwrightian observation that very little of what goes on in the world conforms to the grammar of laws threatens to strip DE of much of its explanatory power. The problem is that, according to DE, potencies contain laws in their essences. Now we may ask: are potency essences *exhausted* by laws, or do potencies dispose their bearers to behave in ways besides those that conform to the grammar of laws? If the former, then DE cannot explain goings on that do not conform to the laws' grammar in terms of potencies, if the latter, it is a mystery why what we learn in the lab about the *lawful* behaviours towards which potencies dispose their bearers, should have any application *outside* of the lab. Either way, DE's explanatory aims are under threat (see sections 2.4 and 2.5 above for details).

The view developed in this chapter is clear on the fact that laws are not contained within potency essences. Rather, a potency, *P*, grounds a range of possible behaviours, what I have called a modal profile. Since, on this view, potencies ground a range of behaviours besides those that conform to the grammar

of the laws, the Cartwrightian observation that the laws "lie" is consistent with potencies nonetheless metaphysically explaining what goes on in the universe.

The laws, according to the Revised Potency-BSA, emerge as higher-level descriptions of the various interactions between all potency instances considered collectively. A proposition's status as a law, on this view, is partly determined by objective facts about potency interactions and partly by its usefulness *to us*. Some true proposition may meet these criteria for lawhood *despite* the fact that very little of what actually goes on in the universe conforms to its grammar *exactly*. The laws' grammar is thus best understood as an artifact of the partly pragmatic grounds for certain propositions being elevated to the status of law – some proposition maybe very useful to us even if very little of what goes on in the universe conforms to its grammar *exactly*. Scientific lab work can then be understood as helping us to decide which propositions will be useful to us in this sense and hence good candidates for lawhood. The laws that we formulate based on discoveries in the lab are thus widely *approximately* applicable to real world settings.

4.8 Conclusion

I have argued that an account of laws in an unHumean world that deserves the name "*best-system account*" must conceive of the laws as descriptive and that those laws must form parts of an *integrated* systematization of the information about a world. More importantly, satisfaction of these desiderata ensures that an account of laws in an unHumean world does not succumb to the various problems raised against dispositional essentialism, which stemmed from that view's questionable strategy of building laws into the essences of potencies, which those potencies were then supposed to metaphysically explain. To this end I propose the Revised Potency-BSA, which I have also argued overcomes the threat of scepticism raised for Demarest's Potency-BSA. The Revised Potency-BSA is also poised to provide a better account of objective chances than the old *Humean* BSA, if, that is, we are more optimistic about the prospects of devising an appropriate weighting function over relevant worlds than we are about overcoming the undermining problem.

5. COMMON GROUND FOR LAWS AND MODALITY

5.1 Introduction

In this chapter, I argue that, given the package of views developed so far, and some further plausible assumptions, facts about laws of nature and facts about metaphysical modality share a common metaphysical ground, namely *potencies*. Potencies are fundamental properties that are necessarily connected with the range of dispositions that constitute their *modal profiles* because they ground those dispositions. Since I endorse Vetter's possibility conception of dispositions, this is tantamount to claiming that potencies ground possibilities. Thus, I use dispositions/possibilities interchangeably (these points were developed in chapter 3).

What I will call *the common ground thesis* is the conjunction of the following claims:

i) the laws are grounded in potencies.

ii) all facts about metaphysical modality are grounded in potencies.

I take the previous chapter to constitute a defence of the first conjunct. There I presented and defended the Revised Potency-BSA. Potencies, I argued, metaphysically determine their actual and possible distributions throughout space-time in accordance with their modal profiles. The laws, according to the Revised Potency-BSA, are then features of a description of this information that best balances the virtues of simplicity and strength. Thus, potencies ground the laws of nature.[22]

[22] To be precise, potencies partially ground the laws in conjunction with our standards of strength and simplicity. More on this in the next chapter.

This chapter will be concerned with defending the claim that all facts about metaphysical modality (henceforth *modal facts*, for short) are grounded in potencies. I will do this by defending the plausibility of the following line of argument:

P1: All modal facts are grounded in potentialities (the central thesis of hardcore actualism).
P2: All potentialities either are or are grounded in potencies.
C: All modal facts are grounded in potencies.

P1 is just the central thesis of hardcore actualism (HA), which I motivated in chapter 1 (in part) by showing how it meshed with the independently plausible denial of R-quidditism. The inference from P1 and P2 to C depends on the plausible assumption that grounding is transitive. Thus, my defence of the above argument in this chapter will primarily consist in defending P2. To do this, I'll first discuss, in section 5.2, the relationship between a hardcore actualist modal metaphysics and necessary connections between properties and their modal profiles at *every level of fundamentality*. In section 5.3, I'll discus metaphysical grounding, which plays the role of ordering potentialities from the less to the more fundamental. Then, in section 5.4, I'll argue that the hardcore actualist metaphysic of potentialities all the way down, in conjunction with plausible definitions of "potency" and "fundamental", implies that all potentialities that are not themselves potencies are grounded in potencies (i.e., P2). P2 in conjunction with P1 and the transitivity of ground, implies that all modal facts are grounded in potencies.

5.2 Hardcore Actualism and 'Potentialities All the Way Down'

According to hardcore actualism (HA), all modal facts hold in virtue of the concrete constituents of the actual world. HA stands in contrast to Lewisian modal realism, which grounds modal facts in concrete worlds that are causally and spatiotemporally *isolated* from actuality (Lewis 1986). HA also stands in contrast to various "softcore" actualist views, which ground modal facts in actually existing *abstract* objects such as sets of propositions (e.g. Plantinga 1976; Cameron 2008), or

uninstantiated properties of a world (e.g. Stalnaker 2003). HA derives appeal from its common-sense concrete object-property ontology; it makes no controversial assumptions about the existence of abstracta or a plurality of causally isolated worlds. By maintaining that metaphysical possibility and necessity ultimately concern how things are with the concrete constituents of the actual world, HA can also claim continuity with science. Science is well placed to yield knowledge of the various actual concrete objects and their properties and hence, given HA, to yield modal knowledge.

In chapter 1, I provided further details of the workings of a hardcore actualist modal metaphysics with reference to Vetter(2015)'s particularly detailed and well-considered version of the view. According to Vetter, irreducibly modal properties that she calls *potentialities*, instantiated by actual, concrete individuals do the work of grounding modality. Potentialities are like the more familiar dispositional properties but form a broader class – all dispositional properties are potentialities but not all potentialities are dispositional properties. Thus, a vase has the *disposition* to break, it is *fragile*, whereas a brick is not disposed to break, though it *can* break – a brick has the potentiality to break. Whether an individual's having some potentiality for M constitutes its being *disposed* to M is a context sensitive matter to which facts about individuals instantiating potentialities are a fully objective and context insensitive backdrop. I also presented, in chapter 1, Vetter's extended understanding of potentiality, which includes *iterated*, *joint*, and *extrinsic* potentialities. With these various pieces in place, the essence of Vetter's hardcore actualism is captured by

> POSSIBILITY: It is possible that $p =_{df}$ Something has an iterated potentiality for it to be the case that p. (Vetter 2015, 247)

In what follows, I use *"potency"* to talk about fundamental level potentialities; potencies thus constitute an important subclass of potentiality. On my view, potentialities and potencies are modal in the sense that they ground, and hence are necessarily connected with, various dispositions/possibilities. Following

Vetter's definition above, I use "hardcore actualism" or "HA" to refer specifically to the view according to which it is possible that $p =_{df}$ something has an iterated potentiality for it to be the case that *p*.

But perhaps there are other ways of being a hardcore actualist if "hardcore actualism" is taken simply as dictating that all modal facts hold in virtue of the concrete (as opposed to abstract) constituents of the actual world. According to Armstrong's combinatorialist modal metaphysics, for example, properties can recombine with concrete particulars which allows for different *possible* states of affairs (Armstrong 1989). Furthermore, Armstrong subscribes to an Aristotelian conception of universals, hence the properties that are able to recombine to yield alternative possibilities must themselves be instantiated by concrete individuals to exist. Nothing in this picture would seem to violate the hardcore actualist dictum.

However, according to Contessa's canonical definition of HA: "what makes modal propositions true are *irreducibly modal features* of the actual world (such as laws of nature, dispositions, or essences)" (2010, 342, my emphasis). It is the idea that the world contains some irreducible modality in the form of irreducibly modal properties (which enjoys some independent plausibility, as discussed in chapter 1) that really motivates the hardcore actualist to then put this modality to work in an account of metaphysical modality in general. What is not clear is that the properties that may be said to recombine, according to Armstrong's modal metaphysics, can be thought of as doing the kind of work expected of them by HA because they are not *irreducibly modal* in the relevant sense. Armstrong's quiddistic view of properties denies that there are any necessary connections between properties and behaviours/dispositions. On Armstrong's view, then, the properties themselves do not seem to be doing any real work in constraining or determining what's metaphysically possible. And this runs contrary to the spirit of HA. But regardless of the status of Armstrong's view and others with respect to HA, to be clear: for present purposes, by "HA" I specifically mean Vetter's potentiality view, which unambiguously gives properties a role in constraining or determining what's metaphysically possible and which is characterized by POSSIBILITY.

Crucial to HA, then, is *realism* about the modal properties that ground modal facts. Realism, in this sense, about modal properties can be understood in contrast with Humean reductionism. The Humean doesn't disagree with the platitude that there are such things as potentialities, including the potentiality to break, or dispositions, including *fragility* and *charge*. Instead, the disagreement concerns the metaphysical explanation of such properties (see Vetter 2015, 24). The Humean typically seeks to explain these modal features of the world in terms of *quiddities* and the truth of counterfactual conditionals, where the latter, in turn, are analysed in terms of possible worlds (see, e.g., Stalnaker 1968; Lewis 2001 for possible worlds analyses of counterfactuals), such that all modal properties are everywhere eliminable. The realist, on the other hand, admits modal properties as irreducible primitives.

Humeanism is one contrast point with the realism about modal properties central to HA. Armstrong (1997), for example, analyses away a vast majority of modal properties in terms of *quiddities* and the laws of nature, where he provides an *unHumean* account of the latter in terms of higher-order necessitation relations between universals (1999). The modality inherent to the necessitation relations remains an unanalysed primitive (hence Armstrong's view is unHumean) in terms of which other modal properties, such as *fragility* and *charge*, are analysed. Armstrong, while admitting *some* irreducibly modal properties, nonetheless analyses away others, such as *charge* and *mass*, whose modal natures the hardcore actualist will admit as real and irreducible.

Since the central thesis of HA is that modal facts are grounded in modal properties of concrete, actual individuals, which, following Vetter, I have been calling *potentialities*, the hardcore actualist must be a realist about these modal properties. If modal properties were understood in accordance with some form of reductionism, then, while strictly speaking something like POSSIBILITY might still be true, it would not tell the whole story. This is because the reductionist would further analyse "a potentiality for it to be the case that *p*" (the hardcore actualist's *definiens*) in terms of something else; possible worlds, be they abstract or concrete (e.g., Lewis), or quiddities and primitive necessitation relations between universals

(e.g., Armstrong).[23] It would then be that *something else* that was really doing the work of grounding modality.

The hardcore actualist's contention is that the *something else* is either more metaphysically suspect than potentialities (realistically construed) or else just not the sort of thing that is relevant to matters of metaphysical possibility and necessity. Possible worlds and Armstrongian necessitation relations certainly seem more mysterious than, say, the potentiality of an actual vase to break or the potentiality of an actual electron to exert a repulsive force, or so the hardcore actualist maintains. Furthermore, the fact that, for example, a vase is fragile, seems *relevant* to the possibility that it breaks in a way that the breaking of some other vase in some other possible world just does not (see, e.g., Jacobs 2010, sec. 3). The mysterious nature of the reductionist's modal truthmakers also raises an epistemological problem – how do we come to *know* about these entities and, hence, about metaphysical modality? HA's modal epistemology, by contrast, is strikingly elegant: science, and everyday empirical inquiry, can tell us about the potentialities of individuals and hence, according to HA, about metaphysical modality.

Of course, in the case of a vase's fragility, this high-level potentiality might be explicable in terms of lower-level potentialities of, say, the vase's constituent molecules and atoms. But what is crucial is that at no point in any such chain of explanation is a potentiality explained in terms of or *reduced* to anything that is not *itself* a potentiality, else HA would be false. Borghini and Williams seem to be getting at this point when they say:

> What matters for our account is that dispositions have as their bases dispositional properties and not some alternative truthmaker; anything less would imply the falsity of our account. That is because we develop our account of possibility on the understanding that dispositionality is the source of [modality]; on all other treatments of dispositions, this [modality]

[23] This imagined Armstrongian modal metaphysics is different to the combinatorialism that he actually endorses, which is touched on above.

> is transferred elsewhere, either to the laws of nature, possible worlds, abstract realms, or what have you. (Borghini and Williams 2008, 24).

And Vetter makes the point that while high-level potentialities may be explained in terms of lower level ones, the realism central to HA just maintains that at no point is a potentiality explained in terms of anything other than another *potentiality*:

> In explaining potentialities on the macro-level, we have to invoke potentialities again, though this time on the micro-level. The realist's contention is not that every potentiality is irreducible or inexplicable. It is rather that, in reducing or explaining one potentiality, we always find ourselves saddled with new potentialities. Hence we can phrase realism about potentiality as the claim that as we progress from the less to the more fundamental levels, we will always find potentialities. It's potentiality 'all the way down'. (2015, 25).

Thus, HA requires an ontology of modal properties – potentialities – *all the way down* to ensure that it is indeed these properties that are doing the work of grounding modality. Anything less would undermine HA's ambitions to provide a common-sense account of modality as grounded in the properties of concrete, actual individuals because we would be forced to look elsewhere, the most obvious alternative being possible worlds, be they abstract or concrete, for the source of modality.

Strictly speaking, HA may remain neutral on the question of whether there is an absolutely fundamental level of reality. As long as it is indeed potentialities that are grounding modal facts, it doesn't matter how far "down" these potentialities go. Assuming, however, that the chain of potentialities from the less to the more fundamental does eventually bottom out (more on this 5.4.2), then the potentialities that populate the ground floor will be the familiar *potencies* discussed in previous chapters, since recall that potencies were defined simply as *fundamental*, irreducibly modal properties. Thus, plausible candidates for those potentialities that

populate the fundamental level will be the plausible candidate *potencies* previously discussed, such as *charge*, *mass*, *spin*, etc.

5.3 Potentialities, Potencies and Grounding

I've touched on a sense in which potentialities might be reduced or explained without thereby implying the falsity of HA. *High-level* potentialities, such as a vase's *fragility*, may be reduced to, or explained in terms of, lower level potentialities of, in this case, the atoms and molecules that compose the vase. So long as we posit potentialities at every level of explanation, *this* type of reduction does not threaten HA because it is still ultimately potentialities that are doing the work of accounting for metaphysical modality. This picture then suggests a commitment to an objective relation of metaphysical grounding between potentialities at different levels and which is related to fundamentality in the following way: the grounded is less fundamental than its grounds (see Vetter 2015, 26–27). Certain facts about potentialities hold *in virtue of* or *because of* other facts about potentialities and we may call this relation *ground*. What it means to say that some less fundamental potentiality is reducible to or explicable in terms of some more fundamental potentialities, is that the latter *ground* the former. A relation of objective metaphysical grounding does the explanatory work.

It is not uncommon to think of grounding as closely related to explanation in this way. Fine, for example, maintains that ground is an explanatory relation: "We take *ground* to be an explanatory relation: if the truth that *P* is grounded in other truths, then they account for its truth; *P*'s being the case holds in virtue of the other truths' being the case." (2001, 15). And Clark and Liggins cite examples of grounding, such as "the brittleness of the cup results from the way its constituent atoms are arranged" and "the truth value of a proposition is determined by how the world is" which "show that grounding is closely related to explanation" (2012, 812). In the former case, the cup's brittleness is explained by its atomic and molecular structure. And in the latter case, the truth of the proposition that grass is green is explained by the greenness of grass. In these examples, grounding is understood as an explanation relation (perhaps among others, such as causation), which is

metaphysical in character; it doesn't depend upon our interests or epistemic standing.

There is an alternative account of the tight connection between grounding and explanation according to which grounding isn't itself an explanation relation but it *backs* or *underwrites* explanations (see Bliss and Trogdon 2016, sec. 4). Audi expresses this view when he says:

> If we recognize [cases of non-causal explanation] and we agree that explanations require non-explanatory relations underlying their correctness, then we are committed to recognizing a non-causal relation at work in these explanations. (2012, 678–8).

For Audi, the non-causal, non-explanatory relation is grounding, which may "back" explanations of a metaphysical *or* an epistemic variety.

The contrast, then, is between a view of grounding as an explanation relation that is metaphysical in character and a view of grounding as not itself an explanation relation but as a non-causal relation that backs various explanations. HA needn't commit one way or the other here. Either grounding is an explanation relation that holds between potentialities at different levels of fundamentality, and this is what it means to say that, e.g., a vase's *fragility* is explicable in terms of its microstructure. Or grounding is some other non-causal, non-explanatory relation that holds between potentialities at different levels and *underwrites* explanations of the higher-level potentialities in terms of lower level potentialities.

There are various nuanced debates about how best to construe the notion of ground, but the hardcore actualist seems able to rely just on some commonly held assumptions (see Vetter 2015, 27–28). Firstly, grounding is not supervenience. Supervenience is analysable in modal terms; A supervenes on B iff it is not *possible* that there be a change in A without a change in B. Grounding, on the other hand, is widely thought to be a *primitive* notion that is not understood in terms of any antecedent modal notions as in the case of supervenience. As a result, grounding can capture explanatory asymmetries where there is no modal asymmetry. For

example, the existence of Socrates and the set whose sole member is Socrates, namely {Socrates}, necessarily coincide. We might think, however, that the existence of Socrates *explains* the existence of {Socrates}, and not vice versa. Since it is the case that in all possible worlds in which Socrates exists, {Socrates} exists and vice versa, supervenience cannot be used to capture the intuitive explanatory asymmetry here. But if we think, as also seems plausible, that Socrates *grounds* {Socrates}, and not vice versa, then the primitive notion of *ground* can be invoked to capture this explanatory asymmetry not capturable by the modal notion of supervenience. In other words, grounding, like explanation, is hyperintensional, where supervenience is merely intensional. Secondly, grounding may be full or merely partial. So, for example, the existence of Socrates fully grounds the existence of {Socrates} whereas *p* only partially grounds *p*&*q* (see, e.g., Fine 2012b).

A further assumption, that ground is a relative fundamentality relation, has already been touched on. Ground, it was suggested, does the explanatory work of ordering potentialities from the more to the less *fundamental*. But to properly induce this fundamentality ordering, and hence do its explanatory work, ground must be a *strict partial order* (SPO) – transitive, irreflexive and asymmetric (see, e.g., Raven 2013, 193–94). This is noteworthy because the transitivity of ground is also required for the inference from P1: all modal facts are grounded in potentialities and P2: all potentialities either are or are grounded in potencies to the conclusion, C: all modal facts are grounded in potencies. Thus, the legitimacy of this part of my argument in this chapter requires no more than what the hardcore actualist is independently motivated to admit.

Furthermore, it was argued in chapter 3 that QDE can, where structuralism cannot, retain the asymmetry of ground. Ground must be asymmetric (and irreflexive and transitive) if it is to do the work that the hardcore actualist would like it to do of explaining the relative fundamentality ordering of potentialities. Hence, the hardcore actualist has a reason to prefer QDE over structuralism as her metaphysic of properties.

Reconsider, then, the potentiality of a vase, v, to break. This potentiality is grounded in the joint potentialities of v's constituent molecules, which are in turn

grounded in the potentialities of those molecules' constituent atoms and subatomic particles so on. A similar grounding story could be told about other potentiality attributions. Another (perhaps more contentious) example is Vetter's potentiality to speak Finnish. This potentiality is grounded in her mental and physical make up, which are in turn grounded in the joint potentialities of molecules and atoms composing Vetter's body. (Here I follow Clark and Liggins (2012, 813), among others, in assuming that mental states are grounded in physical brain states. I'll return to this potentially controversial assumption in the next section). In short: grounding chains descend from high-level potentialities to lower and lower level potentialities.

5.4 *All* Potentialities are Grounded in Potencies

Given the claim, central to HA, that there are potentialities "all the way down" and two further, independently plausible, assumptions, it can be shown that *all* potentialities are grounded in potencies. The first of these assumptions, which has already been introduced, and which is endorsed by, e.g., Bird (2007), is the following definition of a potency:

POTENCY: P is a potency iff P is a fundamental potentiality[24]

The second assumption, endorsed by, e.g., Schaffer (2009), is the following attractive ground-theoretic definition of "fundamental":

FUNDAMENTAL: X is fundamental iff X is ungrounded[25]

For any potentiality, *X*, that is not itself a potency, there will be chains of grounding descending from *X* to lower and lower level potentialities. Wherever any such chain terminates will be some potentialities – because its potentialities *all the*

[24] Though Bird uses the term "essentially dispositional property" instead of "potentiality".
[25] According to, e.g., Schaffer "Part of what makes grounding a useful notion is that it can be used to define a cluster of useful metaphysical notions." (2009, 373). Schaffer offers the following examples: x is fundamental $=_{df}$ nothing grounds x. x is derivative $=_{df}$ something grounds x.

way down – and since the grounding chain *terminates*, these potentialities will be ungrounded. According to FUNDAMENTAL, ungrounded entities are fundamental, hence these ungrounded potentialities are fundamental potentialities. And by POTENCY, fundamental potentialities are potencies. Hence, for any potentiality, *X*, that is not itself a potency, there will be chains of grounding descending from *X* to *potencies*. All potentialities which are not themselves potencies are ultimately grounded in potencies, which is P2 in my argument to the conclusion that all facts about metaphysical modality are grounded in potencies.

5.4.1 An Anti-Physicalist Challenge?

All of the putative examples offered of potencies so far have been the kinds of properties that are familiar to modern *physics* – things such as *charge*, *mass* and *spin*. An *anti-physicalist* may thus be tempted to try and resist P2 on the grounds that *mental* potentialities are neither identical with nor grounded in potencies.

But P2 needn't be denied to appease anti-physicalist sympathies. The anti-physicalist might just deny that mental potentialities are either identical with or grounded in the kinds of potencies that are familiar to *physics*. A position consistent with P2 and that captures the anti-physicalist intuition might thus hold that there are mental as well as physical potencies. In this case, it could still be true that all potentialities are either identical with or grounded in potencies, but the *mental* potentialities would be identical with or grounded in *mental* potencies.

For what it's worth, I'd prefer to retain the physicalist line according to which all potentialities, including mental potentialities, are identical with or grounded in the kinds of potencies familiar to physics. But it is worth noting that P2 itself is neutral with respect to physicalism. It would be beyond the scope of my present inquiry to properly address all of the debates about, e.g., physicalism, mind-body dualism and reductionism relevant to the issue regarding the status of mental properties. But by way of a very tentative defence of my preferred physicalist stance I'd like to briefly attempt to undermine one potential motivation for anti-physicalism.

The anti-physicalist may think that grounding the mental in the physical somehow diminishes the reality of the mental. In response to this, it is important to note that it is no implication of P2 that higher-level potentialities, be they *fragility* or *irascibility*, are any less real for ultimately being grounded in potencies. Grounding, as discussed, is an explanatory relation. So, if A grounds B, then A *explains* B, in a metaphysical sense. But this is not to say that B is any less real for being explicable in terms of B. The vase's fragility is a real property of the vase, which is in no way diminished for being explicable in terms of the vase's microstructure. Indeed, far from A's being grounded in B suggesting the unreality of A, we should perhaps be *more* confident in the existence of grounded entities (Vetter 2015, 28, seems to share this view). After all, if it is granted that grounding is a real *relation* (as indeed I do), then surely its relata must at least *exist* for the relation to hold. So, to say that a grounding relation holds between mental properties and (physical) potencies should in no way be read as diminishing the reality of those mental properties, indeed the contrary would seem to be true.

My aim is to provide a unified account of the laws of nature and metaphysical modality by showing that facts about laws and facts about metaphysical modality share a common ground, namely, *potencies.* Thus, if the laws of nature concern mental potencies as well as physical potencies, then the anti-physicalist interpretation of P2 would be consistent with my broad project. If, however, there were such things as mental potencies which are different in kind from physical potencies and if those mental potencies were not the concern of laws of nature, then my unificatory project would be in trouble. But I think the burden of proof is on whoever would defend the remarkable package of claims that i) there are mental as well as physical potencies (i.e., mind-body dualism) and ii) the laws of nature do not concern the mental potencies. Aside from any incredulity that this package may inspire, I would hope that the competing views I defend here, according to which all potentialities (and hence all modal facts) are grounded in potencies and no potencies are beyond the remit of the laws of nature, combine to yield a more theoretically fruitful picture over all. Hence, one way of rebutting the

conjunction of i) and ii) is to present my own alternative and its theoretical virtues as convincingly as possible, which is what I do in the next chapter.

5.4.2 Infinite Grounding Chains

My discussion thus far has assumed that all grounding chains terminate. If, however, there were infinite grounding chains descending from some, or all, potentialities, then my argument for P2 at the beginning of this section would be in trouble. This is because if there were infinite grounding chains descending from some potentialities, then given POTENCY, those potentialities would not be grounded in potencies because potencies, by this definition, are ungrounded but every entity in an infinite grounding chain has some more fundamental ground.

Given that my aim in this thesis is to develop a theoretically fruitful unified account of laws and modality by building up from some plausible assumptions, I do not think that it would be unreasonable to simply assume that there are no infinite grounding chains for my purposes. This assumption enjoys some intuitive plausibility, and if a plausible assumption combines with some other plausible assumptions to yield an attractive view that is able to do good philosophical work, then this constitutes a good reason to accept that assumption. The virtues of the common ground view will be presented in the next two chapters.

But for what it's worth, I am optimistic about prospects of the common ground thesis even in a world with infinite grounding chains. All that is important to the common ground thesis is that there exists *some* unified class of potentialities in which facts about laws and facts about metaphysical modality are grounded. And this is consistent with the potentialities that make up the common ground being grounded in further potentialities. In other words, what is important is that laws and modality share a common ground, not that the common ground be *fundamental* or *ungrounded.* For the sake of simplicity, however, I will continue to assume that all grounding chains do terminate, hence the official argument for P2 is the one presented at the beginning of this section.

5.5 Conclusion

In this chapter, I have sought to add plausibility to the common ground thesis according to which facts about laws and facts about modality are grounded in potencies. I noted that the previous chapter constituted an argument for the claim that *laws* are grounded in potencies. This chapter was thus primarily concerned with defending the claim that all facts about metaphysical modality are grounded in potencies, which I motivated via a defence of the following argument:

P1: All modal facts are grounded in the potentialities.
P2: All potentialities either are or are grounded in potencies.
C: All modal facts are grounded in potencies.

P1 is the central thesis of HA, which I have argued is independently attractive. The majority of this chapter thus focused on defending P2. To this end, I argued that central to HA is the idea that there are potentialities "all the way down". From this, and the independently plausible definitions POTENCY and FUNDAMENTAL, P2 follows.

6. CHARTING THE COMMON GROUND

6.1 Introduction

I have argued that facts about laws and all facts about metaphysical possibility and necessity are grounded in *potencies* because there are chains of grounding descending from all potentialities that are not themselves potencies to the level of potencies.

To facilitate a more precise discussion of what this implies about the relationship between laws and modality I'd like to show that both laws and modality may be understood as concerning how potencies are possibly distributed throughout space and time. I will then explore the resulting philosophical landscape and conclude the chapter with some objections and replies.

6.2 Laws and Possible Potency Distributions

To facilitate the presentation and evaluation of my positive view of the laws, in chapter 4 I introduced a precise definition of the term "modal profile". In previous chapters, I had used the term "modal profile" somewhat loosely to refer to the full range of dispositions or behaviours that a property grounds. But what is it for a property, P, to ground a range of behaviours/dispositions? I say that it is for P to ground facts about the properties, the X's, with which P is possibly coinstantiated by a property bearer, *x*. P's modal profile is then defined as the range of properties, the X's, with which P is possibly coinstantiated by an individual property bearer, *x*.

To see why this definition of "modal profile" gets at the intuitive idea that P's modal profile has to do with the *dispositions/behaviours* with which P is associated, consider the following. It is allowed that the X's be relational, conjunctive, time-indexed, or otherwise highly gerrymandered. So, the modal profile of P may, for example, specify that P is possibly coinstantiated with the property of occupying location L1 at time T1 and occupying location L2 at time T2. This, in turn, implies something about how any *individual*, *x*, that instantiates P *can*

behave/is *disposed*; *x* can occupy L1 at T1 and L2 at T2 (assuming, of course, that *x* instantiates no other properties that are incompatible with its behaving in this way). Since properties ground modal profiles that have implications for how individual property bearers can behave/are disposed, properties can thus be thought of as metaphysically constraining how they are possibly distributed throughout space and time.

In chapter 4, I argued that potencies ground the laws because the laws are features of a description of (actual and) *possible potency distributions*, where possible potency distributions are metaphysically determined by potencies in accordance with their modal profiles. Hence, the laws of nature are grounded in possible potency distributions.[26]

6.2 Modality and Possible Potency Distributions

According to the version of HA that I endorse, it is possible that φ iff something has a potentiality to φ. In this section I propose an understanding of potentiality in terms of possible potency distributions and hence a modified HA schema according to which it is possible that φ iff some potencies are (or potency is) possibly distributed such that φ.

Reconsider the example of a fragile vase, v. As discussed, the proposition <possibly v breaks> is true in virtue of the vase's *potentiality* to break, in virtue of its *fragility*, for short. But v's fragility, I have argued, is grounded in the potentialities of its constituent molecules and atoms and, ultimately, *potencies*. More precisely, v's fragility is grounded in some potencies *jointly*, since no *single* potency instance suffices by itself to ground v's fragility.

Now what, at the potency-level, would it be for v's *fragility* to be manifested? It would, I suggest, be for some potency instances (*potencies* for short), perhaps those of the vase's subatomic constituents, to be appropriately *distributed*. We might think of v's being broken as a matter of the potencies of v's constituent atoms and molecules being more *scattered* or distributed in a less *orderly* manner

[26] To be precise, laws are *partially* grounded in possible distributions of potencies, they are also partially grounded in facts about our practical and scientific interests, which, in turn, inform our standards of simplicity and strength. I return to this point in section 6.7.

than they would be if v remained unbroken. For some potencies to be distributed someway is tantamount to their being coinstantiated with the appropriate *extrinsic* properties. Thus, *how* some potencies are possibly distributed is grounded in those potencies themselves and implied by those potencies' modal profiles, which specify all the properties, including extrinsic properties, with which they are possibly coinstantiated. In short: whether a vase *can* break is a matter of its having the potentiality to break which is a matter of some potencies' possibly being distributed such that it is broken.

My suggestion is that a similar story could be told about all potentiality attributions. In general, then, I propose an understanding of potentiality as follows:

Potentiality Instantiation:	For *x* to instantiate a potentiality to φ is for some actual potencies to be possibly distributed such that *x* is φ.
Potentiality Manifestation:	For *x*'s potentiality to φ to be manifest is for some actual potencies to be distributed such that *x* is φ.

Thus, I propose an understanding of potentiality, and hence metaphysical possibility, in terms of possible potency distributions, which implies the following:

*HA Schema**: It is possible that φ iff some actual potencies are possibly distributed such that φ.

Possible potency distribution need not be interpreted as an alternative modal primitive to *potentiality*, rather it is a proposal for how to understand what is going on in cases where some potentiality is instantiated and grounded in potencies (which I have argued is the case for all non-fundamental potentialities).[27] For a

[27] Since a potentiality will often be grounded in various potencies jointly, the present proposal can be understood as in a similar spirit to Vetter's discussion of potentialities "fitting" each other as a way of understanding joint potentiality (2015, 114). I just prefer to talk in terms of possible distribution than in terms of fitting and, as I'll argue, I think that all potentialities, even single potency instances, can be understood in these terms.

potentiality to be instantiated is for some potencies to be possibly distributed some way. Saying that *x* has a potentiality to φ is shorthand for saying that some potencies are possibly distributed such that *x* is φ. As was the case when talking in terms of potentiality, modality is not eliminated, the idea is rather that all modal facts can be accounted for in terms of possible potency distributions, where possible potency distributions are grounded in the (qualitative) natures of the potencies themselves (see chapter 3 for discussion of the idea that qualities ground possibilities).

The point of introducing this understanding of potentiality in terms of possible potency distributions is to show that modality, like the laws of nature, can be understood in terms of possible potency distributions. This will, in turn, allow me to say more about what the common ground thesis implies about relationship between laws and modality. Modal facts turn out to be a matter of how some potencies are possibly distributed and laws are features of a *description* of all possible potency distributions.

One might object that metaphysical modality (and hence potentiality) is not in general a matter of some potencies' possibly being distributed some way because some very basic modal fact might need no more than a *single* potency instance to ground it. And no sense can be made of the possible distribution of a single potency. But if we are still allowed to consider the potency instantiated in a manifold of spacetime points, then we can still talk about the possible distribution of a single potency because we can talk about it, say, being coinstantiated with the property of being at point L1 at time T1 and at point L2 at T2, etc., which is tantamount to its being distributed some way. If, however, the thought is that a single potency instance, P, could ground a modal fact independently of absolutely anything, even spacetime points, then it does seem unlikely that P could do so via grounding its being possibly distributed some way. But the obvious response is to bite the bullet here. The intuitive idea behind possible distribution is that some proposition, φ, is possible iff some potencies can be *arranged* or *configured* to bring it about that φ. If a single potency instance considered in complete isolation cannot be

arranged or configured to bring about anything, then it cannot ground any modal facts.

As Vetter notes, we can we can treat individual potentialities as a limiting case of joint potentialities:

> [S]ince a single object is a limiting case of *objects*, the potentialities of a single object are a limiting case of potentialities possessed by objects. We can therefore say that the (joint) potentialities of *objects* are the metaphysical primitive, and leave it open whether those objects are ever more than one at a time. (Vetter 2015, 115).

Similarly, we can take the possible distribution of a single potency as the limiting case of a possible distribution of potenc*ies*. It can thus be maintained that all modal facts concern possible potency distributions while remaining open as to whether those potencies distributed are ever more than one at a time.

6.3 Unifying Laws and Modality

The purpose of the above excursion into the notion of possible potency distributions is that it allows us to see quite clearly the close relationship between laws and modality. On the account presented, laws and modality both have something to do with possible distributions of potencies. For some proposition to be a law of nature is for it to be an axiom of the best systematization of all *possible distributions* of all and only the potencies instantiated at the actual world. For φ to be metaphysically possible is for there to actually exist some potencies that are (or indeed, potency that is) possibly distributed such that φ.

The generality of the laws is such as to imply a wide range of (though probably not *all*) facts about the possible distributions of potencies and hence about what's metaphysically possible. The laws might thus be understood as efficient summaries of all the facts about possible potency distributions and hence as efficient summaries of the space of metaphysical possibility.

Put another way, different *functions* on the possible distributions of potencies yield the laws in one case and metaphysical possibility in the other. Both functions take as input facts about possible potency distributions. The *laws*-function then outputs this information in a manner that best balances strength and simplicity. The result is a kind of *coarse-graining* of the information about possible potency distributions. This is useful for us because it provides easy access to as much of this information as possible, which can then be used to make predictions about, and perform interventions on, our environment to serve our practical and scientific interests. However, the laws-function, in virtue of its coarse-graining effect, will likely omit some information about possible potency distributions. The *metaphysical modality*-function, by contrast, simply takes all information about possible potency distributions as input and then outputs all resultant facts about metaphysical modality. This function loses no information, but it does not present the information in a manner that is particularly accessible or useful to *us*.

In the next chapter, I'll discuss the epistemological and methodological upshots of this view – in a nutshell; modal epistemology is assimilated to familiar scientific epistemology because scientific inquiry into the laws of nature presents our best route to knowledge of what is metaphysically possible. Next, I'd like to situate the *common ground* view with respect to two traditional views about the relationship between physical and metaphysical *necessity*; relativism (e.g., Smiley 1963; Leech 2016) and primitivism (Fine 2005).

6.4 Varieties of Varieties of Modality

In this section, as a way of further illuminating the idea, developed in this thesis, that laws and modality share a *common ground* I will consider the following question: *what is the relationship between physical and metaphysical necessity?*

Physical necessity and metaphysical necessity are often thought to be two among a *variety* of different necessities including perhaps mathematical, logical, normative, legal and others. We might wonder, then, what the relationship is between these various different necessities. In this section, I'll discuss (the

shortcomings of) two familiar competing views of the relationship between physical and metaphysical necessity, what I shall call *relativism* and *primitivism*.

Relativism comes in two slightly different versions: reductive and non-reductive (see Leech 2016, 164). Central to both is the idea that *p* is physically necessary iff *p* follows logically from the laws of nature. But where the reductivist says that there is nothing more to physical necessity than logical necessity relative to some propositions that we call laws, the non-reductive version includes the claim that the laws enjoy their own distinctive, *sui generis*, variety of necessity. According to primitivism, physical and metaphysical necessity are wholly independent and incommensurable varieties of necessity.

I'll discuss some problems for relativism and primitivism before moving on to discuss how best to understand the relationship between physical and metaphysical necessity given the common ground view and how this overcomes the problems faced by relativism and primitivism. The point of this section is not to provide an exhaustive survey of all of the subtly different accounts that are on offer of the relationship between varieties of necessity, such a task would be beyond my present scope. Rather, the intention is to raise the question about the relationship between physical and metaphysical necessity, flag some potential pitfalls to which an account of this relationship may succumb and then to discuss what the common ground view implies and how it can avoid these pitfalls.

6.4.1 Relativism

For the purpose of my discussion of relativism I shall, following Fine (2005, 237), understand logical necessity as a *restriction* on metaphysical necessity such that a truth is logically necessary iff it is metaphysically necessary and a truth of logic. According to this view, logical necessity is just a *species* of metaphysical necessity (Fine 2005, 237).[28]

Relativism takes metaphysical/logical necessity to be absolute, in the sense that if *p* is metaphysically/logically necessary, then there is no alethic sense of possibility according to which it is possible that not-*p* (see Hale 1996; Leech 2016)

[28] Though see, for example, Edgington (2004) for an alternative view.

(by *alethic* I will mean factive and non-epistemic). According to reductive relativism, *p* is physically necessary iff *p* follows logically from the conjunction of truths about the laws of nature and physical necessity is understood as *nothing more* than logical necessity relative to the class of propositions about the laws of nature (Leech 2016, 159, 164). Assuming that logical necessity is a species of metaphysical necessity, it is thus this reduction of physical necessity to logical necessity that the relativist may offer as an account of the relationship between physical and metaphysical necessity. It is clear, then, that if logical necessity weren't a species of metaphysical necessity (see, notably, Edgington 2004 for this view) relativism would not even count as illuminating the relationship between physical and metaphysical necessity. Rather, the account would tell us about how physical necessity reduces to whatever non-metaphysical variety of necessity logical necessity is and it would remain open how metaphysical necessity and this other necessity relate. It is thus interesting to flag here that a not insignificant assumption must be made for relativism to even count as accounting for the relationship between physical and metaphysical necessity. But there are at least two other pressing concerns for this view.

One concern is that reductive relativism risks triviality. Just as we can define physical necessity as logical necessity relative to the conjunction of truths about the laws of nature, we might define wombat-necessity as logical necessity relative to the conjunction of truths about wombats or Argos-necessity as logical necessity relative to the class of truths about the Argos catalogue (see, e.g., Fine 2005; Bird 2007; Wilson 2013; Leech 2016). But physical necessity, unlike wombat or Argos-necessity, strikes us as deeply non-trivial. Thus, if the reductive relativist is to account for the relationship between physical and metaphysical necessity by defining the former in terms of (a species of) the latter, more needs to be said to distinguish between trivial and non-trivial relative necessities.

Leech suggests that the reductive relativist can draw the distinction between trivial and non-trivial relative necessities by appeal to the class of propositions to which the different necessities are relative. The class of propositions about wombats, or items in the Argos catalogue, is of limited interest and scope, and this explains why necessity relative to either of these classes of propositions is itself

trivial. The class of propositions about the laws of nature, on the other hand, is broader and more interesting, hence the non-triviality of necessity relative to *this* class (Leech 2016, 163).

However, this move seems to just shift the explanatory burden, for it leaves unanswered why propositions about the laws are of interest to us, why, for example, are funding bodies more likely to fund research concerning the basic laws of nature than research concerning items in the Argos catalogue? Leech suggests that perhaps this has to do with the fact that the conjunction of propositions about the laws is broader in scope than that about, say, the Argos catalogue (ibid). But breadth of scope can't explain the interestingness of the laws. We can easily get a conjunction of propositions broader in scope than the conjunction of laws by conjoining the laws with the class of propositions about the Argos catalogue. But necessity relative to this broader class is surely *less* important than necessity relative to *just* the laws. The key question is: why is the conjunction of propositions about the laws and, hence, necessity relative to the laws, important? As it stands, the reductive relativist account of the relationship between physical and metaphysical necessity is obscure on this point.

According to another type of triviality concern, reductive relativism trivialises the necessity of the laws themselves. Recall that, according to the reductive relativist it is physically necessary that p iff p follows logically from the conjunction of true propositions about the laws of nature and physical necessity is nothing more than logical necessity relative to the laws. It is thus true trivially that the laws of nature are physically necessary because they are logically implied by themselves and, according to the reductivist, the laws' necessity consists in *nothing more* than their following logically from themselves. However, one might think that the necessity of the laws is a more substantive matter than trivial self-entailment. Here's Fine on the matter:

> The general problem is that a definition of natural necessity as a form of relative necessity will tend to make the necessity of the propositions with respect to which the necessity is relative a trivial or insubstantial matter; yet

> we are inclined to think that the necessity attaching to the laws and the like is not of this trivial sort. (Fine 2005, 247).

However, as Leech discusses (2016, 164), there is a non-reductive version of relativism, which perhaps does better on this score. According to non-reductive relativism, natural necessities are understood as relative just in the sense that they are not absolute, where *p* is absolutely necessary iff there is no alethic sense of possibility according to which it is possible that not-*p.* Thus, according to the non-reductive account of the laws' relative necessity, the laws enjoy some form of necessity, but there is also a sense of possibility, namely logical/metaphysical, according to which for any *p*, if *p* is a law it is possible that not-*p*. And this is what is meant by the claim that the laws are *relatively* necessary. By endowing the laws with a kind of *sui generis* necessity that is weaker than absolute necessity, non-reductive relativism needn't trivialise the necessity of the laws themselves. Physical necessity in general may be then defined as logical necessity relative to the laws of nature and this is supposed to illuminate the relationship between physical and metaphysical necessity without reducing the former to the latter and without rendering the necessity of the laws trivial. The distinctive modal force of physically necessary propositions is then inherited from the distinctive modal force of the laws themselves.

Leech suggests that the lesson for the reductivist is that if they wish to define natural necessity in terms of the laws of nature, then the laws cannot themselves be defined in terms of their being naturally necessary, else the above triviality concern will arise. The suggestion, then, is that if the laws are given some analysis *not* in terms of their being physically necessary (such as, perhaps, a Lewisian *best system analysis* or an Armstrongian analysis in terms of higher-order universals) then the reductivist may be back in business (Leech 2016, 165).

However, the above suggestion raises a critical dilemma for the reductivist. On the one hand, if the proposed analysis of laws does not endow them with some distinctive modal force, then nothing has been done to address the idea that some non-trivial modal force, some *necessity*, attaches to the laws, which needs accounting

for. But, on the other hand, if the analysis of laws *does* endow them with some distinctive non-trivial necessity, then the view would seem to collapse back to the non-reductivist view according to which the laws enjoy their own *distinctive* kind of necessity, which is not reducible to logical necessity. Thus I think that Leech's suggestion that the reductivist needs to provide an analysis of the laws that is independent of their necessity (Leech 2016, 164–65) misses the mark, for if the reductivist succeeds they are either left without an account of the laws' distinctive modal force or a view that is no longer reductive.

I argue, contrary to Leech, that it is the *non*-reductivist who must give an account of the laws not in terms of their being physically necessary, but which nonetheless *explains* their necessity. I take the point that the non-reductivist is better placed to avoid rendering the laws' necessity trivial by granting that their necessity is of a distinctive kind, but noting this point is only part of the job done. It is unexplanatory to merely *stipulate* that the laws enjoy some sort of *sui generis* necessity, the reductivist ought to provide an independently plausible account of the laws from which it follows that they in fact enjoy some such necessity. Only once this has been achieved may we have some confidence in the substance of the laws' necessity and, hence, confidence in the substance of necessity relative to the laws. Indeed, this seems to be Lange's point (2009, chap. 2).

Lange (2009) has argued that two prominent accounts of laws; Lewis's *best system analysis* and Armstrong's nomic necessitation view fail because the alleged lawmakers, on these views, fail to make the laws necessary in the required sense. In a nutshell: Lewis's account just makes laws thoroughly contingent, and Armstrong's view *calls* the laws naturally necessary, but it is unclear how merely bestowing the laws with a name can make them necessary (Lange 2009, 58). It would be beyond the scope of my present inquiry to survey the various analyses of laws and the extent to which they each succeed at securing the laws' necessity. But suffice it to note that an important task is to account for the laws in a way that explains their necessity – simply calling the laws necessary will not do. In section 6.4.3, I'll argue that the laws' necessity comes about because the laws are partially grounded in facts about possible potency distributions, where facts about possible

potency distributions are themselves metaphysically necessary. The laws thus inherit their necessity from their metaphysical ground.

6.4.2 Primitivism

Contrary to the relativist, Fine (2005) has forcefully argued that physical and metaphysical necessity are wholly distinct and incommensurable varieties of necessity. Call this view *primitivism*. In support of his view, Fine appeals to the triviality concerns faced by relativism, as well as to purported counterexamples to relativism, which, for brevity, I shall omit discussion of. Besides, Leech (2016) has argued, with equal and opposite force, that Fine's purported counterexamples to relativism can be resisted. Instead of getting into the nuances of this debate, which unfortunately would lead me too far astray, I just want to put the primitivist view on the table as another contrast point with the common ground view.

So, to reiterate, contrary to relativism, Fine's primitivism takes physical and metaphysical necessity to be wholly independent and incommensurable varieties of necessity, neither of which can be understood or defined in terms of the other. According to Fine, it is the *identities of things* at the source of metaphysical necessity and *the natural order* at the source of physical necessities. Natural necessity is thus *de dicto* and metaphysical necessity is *de re* and "neither form of necessity can be subsumed, defined, or otherwise understood by reference to any other forms of necessity" (Fine 2005, 260).

Primitivism answers the question about the relationship between physical and metaphysical necessity by denying the premise that there *is* any relationship. But if it is denied that there is any relationship between these varieties of necessity, then a new question arises: why think of these both as *necessity* at all? Primitivism, while perhaps avoiding the triviality concerns for relativism, opens up an explanatory chasm.

These issues faced by relativism and primitivism highlight the need for the following:

- An account of the laws' necessity.

- An account of the laws' importance.
- An account of the relationship between physical and metaphysical necessity.

In the next section, I discuss the implications of the common ground view on each of these points.

6.5 Virtues of Common Ground

The common ground view, which results from the conjunction of my preferred version of hardcore actualism and the Revised Potency-BSA, has it all. It explains how the lawmakers make the laws necessary and hence why the laws are important to us. It also points to an account of the relationship between physical and metaphysical necessity that avoids all of the triviality concerns discussed. For the remainder of this section, I'll provide more detail on these points.

The Lawmakers Explain the Laws' Necessity. Recall that, according to the Revised Potency-BSA, the laws at a world, *w*, are the axioms of a description of all possible distributions of all and only the potencies instantiated at *w*, that maximises the virtues of informativeness and simplicity. It has also been argued that *metaphysical possibility* is a matter of how potencies are possibly distributed throughout spacetime. The lawmakers, namely possible potency distributions, are thus facts about what is *metaphysically* possible. Now plausibly, facts about what is metaphysically possible are themselves metaphysically necessary. That is to say that S5, which is characterised by the following axiom $\Diamond\varphi \rightarrow \Box\Diamond\varphi$, is the correct logic of metaphysical modality.[29] Thus, the facts about metaphysically possible potency distributions, which ground the laws, are themselves metaphysically necessary and *this* accounts for the *laws'* necessity.

However, laws are not *fully* grounded in possible potency distributions. According to the Revised Potency-BSA, laws are partially grounded in possible potency distributions and partially grounded in our standards of strength and

[29] The hardcore actualist may need to make additional metaphysical assumptions in order to validate the S5 axiom. Vetter (2015, 213) discusses some such assumptions.

simplicity, which, in turn, depend upon our scientific and practical interests, which are *contingent*. There is thus a sense in which the laws could have been different if our interests had been different. Of course, different interests would do nothing to alter the facts themselves about possible distributions of potencies such as *mass* and *charge* etc., which are indeed necessary. And it is this necessity of possible potency distributions, in which the laws are (partially) grounded, that accounts for the laws' modal force. Those facts that the laws aim to capture in as strong and simple a manner as possible – facts about possible potency distributions – are necessary, hence the laws describe something necessary insofar as they latch on to those facts and this accounts for the modal force of the laws. But strictly speaking the laws, understood as *descriptions*, and not as themselves facts about possible potency distributions, could have failed to be laws, had our scientific interests been different. That is not to say that actual law statements could have been *false*, just that they could have failed to be laws had our interests been different and, hence, if we'd focused our attention on some *other* true generalizations.

For a long time philosophers have debated the modal status of the laws and nowadays there is a clear divide between those who think that the laws are metaphysically necessary (e.g., Edgington 2004; Bird 2007; Wilson 2013) and those who believe that the laws are metaphysically contingent (e.g., Loewer 1996; Lewis 2001; Fine 2005; Schaffer 2005). A potential benefit of the common ground view might then be its ability to capture something of both of these competing intuitions regarding the modal status of the laws. On the one hand, it captures the necessity of the laws by explaining precisely why those facts described by the laws are metaphysically necessary. On the other hand, by conceiving of the laws as descriptions formulated by *us* to serve practical and scientific ends, it remains metaphysically possible that those very descriptions were never elevated to the status of law, so there is a sense in which the laws are contingent too. I do not, however, intend to suggest that the contingentists are making any kind of error – I do not think that that they are confusing law statements with the nomological facts themselves. So perhaps the contingentists will remain steadfast in their conviction that it is the nomological facts themselves that are contingent, not just facts about

what we happen to call "laws", and hence reject the claim that the common ground view does anything to satisfy their stance.

However, I think there is some scope to push back against this steadfast contingentist response. What the common ground view can capture is the possibility that the world seemed very different to us and that this difference was accompanied by a difference in the laws. In this respect, it may be argued that the common ground view captures something of the contingentist intuition. To see how the common ground view can achieve this, consider the following. A world that seemed very different to us, and which is possible according to the common ground view, is one in which our cognitive and/or perceptual capacities are very different from actuality. Perhaps, for example, one such difference in this world is that we primarily experience our surroundings through *echolocation*. But if we had different cognitive and/or perceptual capacities, our standards of strength and simplicity and, hence, *the laws* would be different too. According to the common ground view, then, there are possible worlds in which it is the case that things seem very different from actuality and the laws are different, which, I suggest, gets at something of the contingentist motivation.

Admittedly, contingentists have other, more robust reasons for their position than wanting to capture the intuition that the world might *seem* different and that this difference be accompanied by a difference in which propositions count as laws. Schaffer (2005), for example, argues that our best semantics for counterfactuals requires that the nomological facts themselves be contingent. In the next chapter, I address this point and others in the course of defending the kind of necessitarianism about the laws implied by the common ground view.

The Laws' Importance Explained. The laws summarise facts about how potencies are possibly distributed, hence they summarise facts about what is metaphysically possible. Metaphysical possibility is possibility *simpliciter* thus the laws are important because they present information about possibility *simpliciter* in a way that is intelligible and useful to us in our practical and scientific endeavours. The laws' importance, on this view, has little to do with their breadth of scope (contra, e.g., Leech 2016, 163), rather it comes about partly through inheritance

from the importance of the facts that they describe and partly because they present these facts in a way that is *tractable*, which is important for various scientific and practical ends.

The Relationship Between Physical and Metaphysical Necessity. I've provided an account of the laws, namely the Revised Potency-BSA, I've explained how the lawmakers, namely possible potency distributions, account for the laws' modal force and I've explained the importance of the laws, which consists in their providing a tractable presentation of information about possibility simpliciter. It might seem natural, then, to accept the following:

?POSS?	*p* is physically possible iff *p* is logically *consistent* with the Revised Potency-BSA laws
?NEC?	*p* is physically necessary iff *p* follows logically from the Revised Potency-BSA laws

safe in the knowledge that the triviality concerns are avoided given the independent account of the laws' necessity and importance outlined above. However, there is at least one strong reason against accepting ?POSS? and ?NEC?.

It seems plausible that if it is physically possible that *p* then it is metaphysically possible that *p*. The validity of this inference is something that we should seek to accommodate. However, ?POSS? and ?NEC? render this inference *invalid*.

The laws, recall, are efficient summaries over the space of metaphysical possibility, in virtue of being axioms of the maximally strong and simple description of possible potency distributions. It is thus possible that the maximally strong and simple system of laws *fall silent* on some facts about metaphysical possibility; the addition, or complication of some law to capture just one more proposition about what's metaphysically possible/necessary might add strength but at too great a cost in simplicity. So, *p* might be consistent with the laws just because the laws fall silent about *p*. It might nonetheless be the case that *p* is metaphysically *impossible* because, as a matter of fact, no potencies are possibly distributed such

that *p*. So, if we want to retain the implication from physical possibility to metaphysical possibility, we should not understand *p*'s physical necessity as consisting in *p*'s following logically from the Revised Potency-BSA laws and hence we should not understand *p*'s possibility as consisting in *p*'s being logically consistent with the Revised Potency-BSA laws. Hence, although the present view provides a good account of the laws' necessity and importance, this is not enough to rescue relativism, definitive of which are biconditionals along the lines of ?POSS? and ?NEC?.

When asking about the respective natures of physical and metaphysical necessity and about the relationship between the two, there is an implicit assumption that there really are distinct varieties of alethic (by which I mean factive, non-epistemic) modality, from among which we can pick out physical and metaphysical modality and then say something about how they are related. My inclination, however, is to deny the assumption that *alethic* modality really does exhibit this diversity. I have defended an account of metaphysical modality in terms of possible potency distributions and my inclination is to just stop there. That is, I am inclined to say that there is just one type of alethic modality and it is a matter of how potencies are possibly distributed. You can call this type of modality what you want – metaphysical, physical, *schmisical* – but there is just *it*.[30] What justifies this? Well, so far, I have so far defended an attractive picture of properties, laws and modality and how they relate and if within that picture there is no room for a diversity of alethic modalities from among which we might pick out distinct varieties corresponding to *physical* and *metaphysical* modality, then so be it. On my view, there are the metaphysical modalities and efficient descriptions of them. No further modalities have been introduced. The result is a very parsimonious picture with various other theoretical benefits discussed in this chapter and the next.

In the next chapter I will say more about the benefits of *identifying* physical and metaphysical modality, which is one way of understanding the present

[30]A caveat: perhaps there are also some acceptable restrictions on this modality. We might, for example, think of chemical, biological and psychological modalities as distinct subsets of the space of metaphysical modality. Thus, we might say that *p* is biologically necessary iff it is metaphysically necessary and a truth of biology. But this way of distinguishing different modalities just involves carving up the one true modal space into different categories.

suggestion, but for now, suffice it to note the following. This account doesn't require us to controversially assume that logical necessity is a species of metaphysical necessity to account for the relationship between physical and metaphysical necessity. The relationship is *identity*. Nor does it succumb to any of the triviality concerns that faced the relativist view. Primitivism made a mystery of the connection between physical and metaphysical necessity in virtue of which both are rightly called types of *necessity.* The present view, on the other hand, makes this connection very clear because physical necessity just is metaphysical necessity, which is fully grounded in possible potency distributions.

The above considerations are, however, consistent with *distinguishing* physical and metaphysical necessity but denying that the former is an *alethic* modality. We might grant that a proposition's physical necessity consists in its following logically from the Revised Potency-BSA laws and that physical possibility consists in being logically consistent with the Revised Potency-BSA laws. But instead of holding that physical modality, so construed, is alethic, we might say instead that it is epistemic. Since the laws package up information about metaphysical possibility in a way that is useful and accessible *to us*, physical possibility, defined as consistency with the laws, is quite naturally understood as epistemic. If physical modality is epistemic, then it is unproblematic to deny the implication from physical possibility to metaphysical possibility because epistemic possibility does not entail metaphysical possibility. Physically modality so construed thus constitutes a representation of a scientific community's (imperfect) *knowledge* what is absolutely (alethically) possible/necessary.

But to reiterate: the *official* view that I shall work with is simply that according to which there is only one type of alethic modality, where sometimes I'll express this with the claim that physical and metaphysical modality (both construed as alethic) are *identical.*

In the next chapter, I'll argue that one of the primary advantages of the common ground view is its potential to unify scientific and philosophical inquiry by justifying the use of scientific inquiry into the laws as a route to (alethic) modal

knowledge.

6.6 Some Objections and Replies

I've suggested that there is just one type of alethic modality (though perhaps it admits of acceptable restrictions – see fn. 24, above), which is a matter of possible potency distributions. The laws of nature get their modal force and are important because they package up information about necessity *simpliciter* in a way that is convenient for *us*. I thus present a unified account of laws of nature and metaphysical modality. In this section, to finish the chapter and to further elucidate the position developed, I'll present some objections and replies.

Objection: Logical and mathematical modality are species of metaphysical modality, but logical and mathematical possibilities and necessities are not grounded in potencies. Hence, you have not provided a properly unified account of laws and (all forms of) metaphysical modality.

Reply: It is not compulsory to think that logical necessity is a species of metaphysical necessity. Edgington (2004) offers examples of propositions that are logically necessary but metaphysically contingent. According to Edgington, logical necessity is identical with being knowable *a priori*. Hence, for Edgington, logical necessity is an epistemic notion that is wholly distinct from metaphysical necessity.[31] Alternatively, one might, for example, take the availability of different logics (classical, intuitionist, fuzzy, paraconsistent, etc.) to cast doubt on the idea that logic is an objective, interest and context-insensitive, species of metaphysical modality. The point, then, is that the common ground view is best accompanied by a view of logical necessity as epistemic or interest relative and hence not within the remit of an account of *metaphysical* modality.

Regarding mathematical necessity, one option is to adopt fictionalism about mathematical truths and hence about mathematical necessities. If it is maintained that mathematical statements are only true 'according to fiction', then plausibly, statements of mathematics would not qualify as metaphysically necessary (see Vetter 2015, 278), and so the problem at hand would not even arise. Alternatively,

[31] Though Hale (2015) and Rumfitt (2010) challenge Edgington's argument.

the nominalist who *does* want to say that mathematical statements are non-vacuously true, but not so in virtue of *abstract* objects, develops a strategy for grounding their truth in concrete objects (e.g., Field 1980). Following Vetter (2015, 281) we might then say that whatever unobjectionable concrete objects ground mathematical truths have *potentialities* that ground those truths and those potentialities will, in turn, be a matter of possible potency distributions as discussed earlier in this chapter. Of course, more would need to be said on these issues, but it certainly seems that there are at least these two plausible avenues of response to the present objection.

Objection: You say that physical and metaphysical necessity are one and the same – both fully grounded in possible potency distributions. But physical necessity is weaker than metaphysical necessity because some physical necessities, such as the fact that nothing travels faster than the speed of light, are metaphysical contingencies.

Reply: I have suggested that there is just one type of alethic modality (I have left open the option of distinguishing physical and metaphysical modality if the former is understood as epistemic). Perhaps some will find this counterintuitive, but it is not really in the spirit of the picture developed here to afford too much weight to *intuitions* on matters modal. By recognising just one type of alethic modality, call it *metaphysical*, and by conceiving of the laws as summaries over the space of metaphysical possibility, science becomes the primary mode of inquiry into what is metaphysically possible/necessary and intuitions are forced to take a backseat. Science formulates laws, and these laws provide a range of knowledge of metaphysical modality. I'll discuss these epistemological and methodological benefits in more detail in the next chapter. For now, I'd like to argue, more simply, that holding on to the intuition that physical necessity is a distinctive form of alethic necessity that is weaker than metaphysical necessity is really at the root of the problems discussed for relativism and primitivism, which constitutes a good reason to reject orthodoxy in this respect.

For a variety of necessity, L* to be *weaker* than a distinct variety of necessity, L, is for it to be the case that L-necessity implies L*-necessity, but not vice versa.

Thus, according to orthodoxy, metaphysical necessity implies physical necessity, but not vice versa, because some physically necessary propositions are metaphysically contingent, but not vice versa. The two main accounts of the relationship between physical and metaphysical necessity that accommodate the idea that physical necessity is *weaker* than metaphysical necessity, in the above sense have already been discussed; they are *relativism* and *primitivism.* According to the relativist, *p* is physically necessary iff it is metaphysically necessary relative to some class of propositions, φ, perhaps about the laws of nature. But φ is itself metaphysically contingent, according to the relativist. So, *p* might be physically necessary but metaphysically contingent because its necessity is only relative to φ, which is itself contingent. Similarly, Fine (2005) takes the purported fact that some physical necessities are metaphysical contingencies as a datum to be accommodated. For example, Fine claims that it is physically necessary but metaphysically contingent that there is no *schmass.* Any claim to the contrary, Fine asserts, would be "too outlandish to deserve consideration" (Fine 2005, 240). Examples such as this partly motivate Fine's view according to which physical and metaphysical necessity are wholly distinct and incommensurable varieties of necessity each with its own distinctive modal force.

The problems with relativism were that it risked trivializing both physical necessity and the modal status of the laws themselves. Relativism's failures in this respect are plausibly diagnosed as stemming from its attempt to capture the *intuition* that physical necessity is weaker than metaphysical necessity. To capture this intuition, the relativist must identify some privileged class of propositions, φ, relative to which the physical necessities are metaphysically necessary, but which are themselves metaphysically contingent. The following questions then arise: why should we care about φ in particular and, hence, metaphysical necessity with respect to φ? And, what accounts for the non-trivial modal force of φ itself? These are difficult questions, questions that I argued the common ground view, which recognises just *one* type of alethic modality, can overcome and hence, which provided motivation for the common ground view. But the common ground view may be understood as answering these difficult questions by the very fact of its

identifying physical and metaphysical necessity and hence denying the *intuition* that physical necessity is weaker than metaphysical necessity. Once physical and metaphysical necessity are *identified* with one another, the importance of the laws, which describe some of those necessities, is no longer a mystery and the non-triviality of physical necessity itself is no longer a mystery because it is really necessity *simpliciter*.

Primitivism makes a mystery of the relationship between physical and metaphysical necessity, in virtue of which they both deserve to be called *necessity*. But Fine's arguments for primitivism are premised on the idea that physical necessity is weaker than metaphysical necessity, in the sense defined above. Thus, if the assumption that physical necessity is weaker than metaphysical necessity is part of an argument for primitivism, which is problematic for opening an explanatory gap, then the assumption that physical necessity is weaker than metaphysical necessity is part of that problem. So, by denying the intuition that physical necessity is weaker than metaphysical necessity we can block the argument for primitivism, and, hence, block the explanatory problems heralded by that view.

In both cases, the assumption that physical necessity is weaker than metaphysical necessity is at the heart of the problems, which can be avoided by recognising just one type of alethic necessity. I thus suggest that we are justified in embracing the common ground view which, in a very principled manner, denies the intuition that physical necessity is a distinctive weaker alethic necessity than metaphysical necessity.

Objection: According to the Revised Potency-BSA, the *actual* laws concern possible distributions of all and only those potencies instantiated at the actual world. However, metaphysical modality concerns potencies that are *alien* to the actual world too. Alien potencies such as *schmarge* and *schmass*, for example, are metaphysically possible, but beyond the remit of the natural laws, concerned as they are only with *actual* potencies. Hence, the laws of nature and metaphysical modality are not properly unified.

Reply: The point of this objection is that laws and metaphysical modality are not unified because metaphysical modality concerns some entities that are not the

concern of the laws, namely *alien* potencies. There are potentially two distinct points that it will help to disambiguate here. One is that alien potencies, such as *schmarge* and *schmass*, are metaphysically possible but of no concern to the laws. The other is that alien potencies, such as *schmarge* and *schmass*, are themselves possibly distributed in various ways and hence give rise to various metaphysical possibilities beyond the remit of the laws.

I have argued that, according to the hardcore actualist component of the common ground package, it is possible that φ iff some actual potencies are possibly distributed such that φ. So, if it is possible that *schmass* is instantiated, then this will be because some actual potencies are distributed such that *schmass* is instantiated. Since this possibility is grounded in possible distributions of actual potencies, it *is* the sort of thing that could in theory be implied by the laws.

Now we might also say that *schmass* is itself possibly distributed such that φ* and hence that φ* is metaphysically possible. But since this metaphysical possibility is grounded in the possible distribution of an alien potency, it seems that the modal proposition <possibly φ*> is beyond the remit of the laws because the laws, by definition, are unconcerned with possible distributions of alien potencies. However, the proposition <possibly φ*> if true, is really an *iterated* modal proposition, ultimately grounded in *actual* potencies. Some actual potencies are possibly distributed such that *schmass* is instantiated and *schmass* is possibly distributed such that φ*. So, <possibly φ*>, if true, is ultimately grounded in possible distributions of *actual* potencies and hence is at least in theory within the remit of the laws – <possibly φ*> is not grounded in any entities that are not the concern of the laws.

One might define a *super* alien potency as follows (see also Vetter 2015, 269): *P* is super alien iff no actual potencies are possibly distributed such that *P* is instantiated. Now the objector above might have super alien potencies in mind. If it were metaphysically possible that super alien potencies were instantiated and if super alien potencies could themselves ground metaphysical possibilities, then there would be some metaphysical possibilities well and truly outside the remit of the laws because the laws concern only possible distributions of *actual* potencies.

But such an objector would beg the question against the present view because to assume that super alien potencies are possible is to assume the falsity of the claim that all possibilities are grounded in possible distributions of *actual* potencies.

I by no means intend to suggest that the objections and replies presented here are exhaustive. Rather, I hope to at least gesture at how some of the most obvious lines of criticism might be addressed. The objections considered here express a common theme, that is a kind of incredulity about what the common ground view implies for orthodox views about laws and modality and about what is, and what is not, metaphysically possible. It is true that the view developed perhaps has some counterintuitive implications. But this should be expected of a view that grounds modal truths not in our imaginative capacities or conceptual schemata, but in those concrete constituents of the actual world that are the primary concern of *science*.

7. *DEMYSTIFYING MODALITY*

7.1 Introduction

In this chapter, and to conclude the thesis, I'd like to say more about the benefits of identifying physical and metaphysical modality, namely, metaphysical modality is demystified and the epistemology of modality is assimilated to familiar scientific epistemology. This chapter thus constitutes a more extended defence of a particularly controversial feature of the common ground view.

7.2 Philosophy and Metaphysical Modality

Metaphysical modality is an important and interesting subject in its own right, but it is also important to philosophical inquiry more generally. All manner of philosophical arguments across a variety of subdisciplines are premised on purported metaphysical possibilities. The following are just a few of the many examples.

The famous *Zombie Argument* (e.g., Chalmers 1996) in the philosophy of mind argues from the metaphysical possibility of zombies – exact physical duplicates of you or I which lack conscious experience – to the conclusion that physicalism is false. Run-of-the-mill sceptical attacks on ordinary knowledge claims argue from the metaphysical possibility that we are, say, brains in vats to the conclusion that we cannot know that we have hands. In the philosophy of religion, the metaphysical possibility that there exists a perfect being, where perfection includes necessary existence, has been invoked to argue that there *actually* exists a perfect being (e.g., Plantinga 1974). In ethics, the metaphysical possibility of a *utility monster* – a being which derives more utility from each unit resource than any other being – has been invoked to argue against utilitarianism (Nozick 1974). And in the metaphysics of modality itself, Fine (2005) has argued from the possibility of alien properties, such as *schmass*, to the conclusion that physical and metaphysical

necessity are distinct and incommensurable. (See also van Inwagen 1998 for more examples and for discussion of so-called *possibility arguments*).

The centrality of metaphysical modality to philosophy makes the questions of *what* metaphysical modality *is* and how philosophers can *know* what is metaphysically possible or necessary, particularly pressing. If philosophers' claims to modal knowledge turn out to be on shaky ground, then large parts of the wider philosophical edifice may be at risk of collapse. So, on what basis can philosophers claim to *know* that zombies, perfect beings, sceptical scenarios, utility monsters or alien properties are possible? A historically popular answer is that whatever can be conceived of, or imagined, is metaphysically possible, and since we have privileged epistemic access to our own imaginings, we are able to know these modal truths. In a similar vein, one might say that it is because stories about, e.g., zombies and perfect beings engender no logical contradictions that they are possible, hence we can use our logical prowess to acquire modal knowledge.

However, superluminal travel speeds and the Bohr atom, for example, are conceivable ways a world might be, which engender no logical contradictions, yet we know that it is impossible to travel faster than light speed and we know that actual atoms are nothing like Bohr's model, which is really an impossible description given the quantum nature of the reality that it is supposed to describe. Conversely, scientists of the past, and likely a great many present-day non-scientists, would find much of what constitutes the modern scientific image utterly inconceivable, and some scientists have even taken experimental data from quantum mechanics to show that the world violates classical logic. Such considerations may reasonably lead one to question whether either conceivability or logical consistency has anything to do with what is really possible.

Perhaps the obvious response to the above is to notice the shift from talking about metaphysical modality to talking about mere physical modality and then to claim that all my examples have shown is that conceivability and logical consistency cannot guide us as to the physically possible. Nevertheless, doubt can still be cast on the supposed link between inconceivability and metaphysical impossibility by providing evidence to the effect that something "inconceivable" is actual and hence

possible. And doubt can be cast on the link between (classical) logical inconsistency and impossibility by providing evidence to the effect that the actual world violates the laws of (classical) logic.

More broadly, we might wonder why metaphysical possibility should be so very different from physical possibility. Both claim to be about objective reality, and both are types of possibility, so why should we be so confident in our ability to investigate the former solely from the armchair and largely via *a priori* methods, when empirical methods have proved so successful a means of investigating the latter? It is the empirical nature of scientific inquiry and its practical applicability that gives us some confidence that the physical possibilities and necessities that science discovers make some contact with objective reality. The popular armchair method of inquiry into matters of *meta*physical modality, by contrast, should raise suspicions that perhaps we are not investigating the nature of objective reality at all and are instead doing something more like investigating philosophers' stories and imaginings.

Two concerns arise for the orthodox view about modality according to which the space of metaphysical possibilities outstrips that of *mere* physical possibilities:

> MYSTERY: Metaphysical modality is mysterious; what is this feature of reality, which by its very nature is beyond the remit of science and to which we have unique access via our intuitive or conceptual capacities?
>
> EPISTEMOLOGY: Why should our intuitive or conceptual capacities reliably inform us about this mysterious feature of reality – how is it that we can have modal knowledge?

In recent years, several philosophers have expressed scepticism about the received "gap" between physical and metaphysical modality whereby metaphysical possibility is thought to outstrip mere physical possibility and which in turn justifies a disregard for empirical considerations when considering metaphysical

modality. A common thought among these dissenters is that if there is *no* gap between physical and metaphysical possibility then two distinct advantages present themselves, which constitute answers to MYSTERY and EPISTEMOLOGY, respectively:

> A1: Metaphysical modality is *demystified*; it is no more mysterious than familiar *physical* modality.
>
> A2: The epistemology of modality can then be assimilated to familiar scientific epistemology; science is a good guide to what's physically possible and, hence, a good guide to possibility *simpliciter.*

7.3 Mind the Possibility Gap!

In this section, I'll outline some arguments in the literature in favour of identifying physical and metaphysical modality and according to which science constitutes our best route to modal knowledge. In section 7.4, I'll discuss how the common ground view closes the possibility gap in a very *principled* way and, hence, provides principled answers MYSTERY and EPISTEMOLOGY.

7.3.1 Edgington and Kripke

An early defence of the idea that metaphysical possibility is "constrained by the laws of nature", as she puts it, can be found in Edgington (2004). Edgington suggests that with Kripke's separation of the necessary and the *a priori* space is left for the metaphysical necessity of the laws. That is to say, we cannot prejudge the laws' modal status purely on the basis of a failure to know the laws *a priori.* And, according to Edgington, this closing if the gap between physical and metaphysical modality has the benefit of demystifying the latter (2004, 2).

To motivate her view, Edgington argues that contingentists about laws have failed to properly distinguish between lawful regularities and *merely* accidental regularities. The best attempt to draw this distinction, Lewis' best system analysis (BSA), does not really capture our concept of *laws* for various well-rehearsed

reasons (it struggles to capture the laws' necessity and explanatory power, for example). Edgington takes the problems faced by the best contingentist attempts to distinguish lawful regularities from merely accidental ones, as well as our tendency to think of the laws as necessary, to count in favour of the claim that the laws are necessary *simpliciter*.

Later in the paper, Edgington draws our attention to the penultimate sentence of Kripke's *'Naming and Necessity'*:

> The third lecture suggests that a good deal of what contemporary philosophy regards as mere physical necessity is actually necessity *tout court* (Kripke 1980, 164).

And, in reference to this quote suggests that:

> Many of Kripke's remarks in defence of particular metaphysical possibilities are naturally read as though this [i.e., that physical necessity is necessity *tout court*] were true (Edgington 2004, 15).

Which is to say, many of the examples of possibilities that Kripke cites,[32] such as

> 1) If Hesperus had been hit by a comet, it might have been at a different position at that time (1980, 58)

and

> 2) If heat had been applied to stick S at t_0; then at t_0 stick S would not have been one meter long (1980, 55)

are compatible with metaphysical necessity being constrained by the laws of nature (Edgington 2004, 16).

[32] Edgington presents 4. I'll give just 2 here for brevity.

It is tacit in 1 and 2 that the consequents, i.e., Hesperus being in a different position at some time and stick, S, not being 1 meter long at t_0, are metaphysically possible, and these possibilities would require no law violation to realise. What's more, Edgington suggests it is likely *due* to their consequents' compatibility with the laws that we find these statements so plausible. To push this point, Edgington modifies the possibilities so that they require a law violation to realise and asks whether they indeed survive *as* possibilities. If metaphysical possibility is unconstrained by the laws then they *should* survive, but it is far from clear that they do, as illustrated by the following modification of the Hesperus example:

> 1*) The astronomical situation into which Hesperus was born was such that there is nothing else around which could (given the laws of nature) interfere with its course. Add, if necessary, that these are the only circumstances in which Hesperus could have come into existence. Does the metaphysical possibility (as opposed to the *a priori* possibility) survive? (Edgington 2004, 16).

That is to say, does the possibility that Hesperus had a different orbit, which is tacit in 1, survive? Besides flagging the potential reluctance one may have to accept the purported metaphysical possibility that Hesperus had a different orbit *given* the situation described in 1*, Edgington is concerned that if we do accept it, i.e. if we think metaphysical possibility is not constrained by physical possibility, then "the manner of defending the original claims is potentially misleading" (2004, 16) i.e. the manner of defending possibility claims like 1 and 2 above is potentially misleading. What makes Kripke's cases compelling, is that we "intuitively read them as natural possibilities" (2004, 16).

Edgington suggests that our readiness to accept that there are metaphysical *necessities* not knowable *a priori*, i.e. our readiness to assent to one of Kripke's key conclusions in *Naming and Necessity*, may be partly explained by our reading these *a posteriori* metaphysical necessities as *natural* necessities.

This last point is a subtle and interesting one that could be made clearer. To that end, the structure of Edgington's argument seems to be something like this: we think (or some people think), having read *Naming and Necessity*, that there are some metaphysical necessities that we can only come to know *a posteriori*, such as that water is necessarily H_2O, i.e., we are persuaded by Kripke's arguments on this score. A *good explanation* for how it is that Kripke manages to persuade us that there are some *a posteriori* metaphysical necessities is that at first blush we read these necessities as *natural* (physical) necessities, which we grant willingly. But since Kripke's arguments ultimately serve to convince us that these are *a posteriori metaphysical* necessities, physical and metaphysical necessity must coincide.

I won't comment on the soundness of the above reasoning, since my current concern is not with the sort of Kripke exegesis that would be needed to make clearer the limits of the argument. So, for now it will suffice to note just that *Edgington* finds in the structure and persuasiveness of Kripke's arguments some evidence in favour of the idea that there is *no* gap between what's physically and what's metaphysically possible and indeed encourages this interpretation of Kripke.

Metaphysical possibility, for Edgington, is thus more constrained than those possibilities that cannot be ruled out *a priori*, which she files under the heading of *epistemic* possibility. Metaphysical possibility, according to Edgington, is possibility for *this* world and those actual things we find in it (2004, 21). It shouldn't be so surprising then that this sort of possibility is constrained by the natural laws if, as seems reasonable, there is some interesting connection between the things that constitute the world and the laws in accordance with which they behave. (*My* preferred account of this connection is developed in chapter 4, there I argue that the laws of nature are a matter of how actually instantiated basic properties are possibly distributed throughout space and time).

7.3.2 Concern with the Methodology of Metaphysics

The epilogue to Maudlin's 2007 collection of essays *"The Metaphysics Within Physics"* is concerned with the methodology of metaphysics. Maudlin takes issue with the type of reasoning that helps itself to substantial metaphysical assumptions, in the

form of metaphysical possibilities, in order to draw metaphysical conclusions. Maudlin cites an argument offered by Kripke and Armstrong (in lectures delivered in 1979 and 1980, respectively); 'the problem of homogenous spinning discs', as his case in point. In this argument, it is asserted that two situations are *possible;* one in which a homogenous disc is spinning about an axis of symmetry and one in which a qualitatively identical homogenous disc is not spinning. It is then argued that a metaphysical view is strengthened (weakened) to the extent that it can (cannot) accommodate these two distinct possibilities.

The problem with this argument, according to Maudlin, is that we have no reason to accept its premises because we have no good reason to think that homogenous discs are possible, and indeed we have *good* reason to think them *impossible*. Physics tells us that matter is *not* homogenous, thus, according to Maudlin, "we have every reason to believe that there is no such thing as 'perfectly homogenous' matter" (2007, 185). Furthermore, Maudlin argues that since all of our experience of matter is experience of *actual* matter and since there is no *actual homogenous* matter, we have no good reason to think that homogenous matter (even if it were possible) should have available to it the distinct states of motion appealed to in the argument, namely rotating and non-rotating.[33]

Of course, the metaphysician may respond at this point by claiming that since metaphysical possibility extends beyond physical possibility, the physical impossibility of homogenous matter does not preclude its metaphysical possibility, from which we may draw the conclusions of the homogenous spinning discs argument. But this move, as Maudlin puts it: "makes metaphysics out to be nothing but *the analysis of fantastical descriptions produced by philosophers*, and, not surprisingly, these fantastical descriptions will have in them whatever features the philosophers decide to put into them" (2007, 188). Maudlin's suggestion, then, is that without some serious reason, besides what we can *conceive* of, to think something possible, we fail to make any contact with reality. Discussion of such ungrounded possibilities is thus of minimal relevance to ontology or metaphysics

[33] Maudlin goes on to note that physics does recognize a homogenous entity, namely a *field*, but that no sense can be made of rotating fields.

more broadly, concerned as it is with the most general, but nonetheless objective, features of reality.[34]

The natural alternative to the kind of metaphysics with which Maudlin takes issue would then seem to be a metaphysics that is more sensitive to science, concerned as it is with the actual world and the *laws of nature*. If we take physical and metaphysical modality to be identical and, hence, take the laws as our best guide to what is metaphysically possible, then we can increase the likelihood that our metaphysics will make some contact with reality. This helps to protect against a kind of metaphysics that *merely* provides analyses of *fantastical descriptions produced by philosophers*.

7.3.3 Bolstering Modal Necessitarianism

Call the view according to which there is no gap between physical and metaphysical possibility, because physical and metaphysical modality are identical, *modal necessitarianism*, MN for short (MN, I have argued, is an implication of the common ground view, which recognises just one kind of alethic modality). Schaffer (2005) seeks to undermine the motivation for MN and to show that proper understanding of some important philosophical issues requires a gap between physical and metaphysical possibility. Wilson's (2013) defence of MN largely consists in responding to Schaffer's criticisms of the view but in the process of responding to Schaffer, Wilson also presents a positive case in favour of MN.

Two of the motivations for MN that Schaffer criticizes are 'the argument from natural necessity' and 'the argument from sustaining counterfactuals'. According to the first, since like charges, for example, *must* repel, the relationships between properties and their powers cannot be contingent (in other words, laws, construed as concerning properties and their powers, cannot be contingent) and hence are necessary. Schaffer responds that the modal force of the '*must*' here is that of natural necessity, which is a restricted form of necessity in the sense that natural

[34] I suppose this is a somewhat controversial stance on the subject matter of metaphysics. Some will staunchly deny that metaphysics is concerned with the world, as it exists independently of human thought and language. But call what I, and the authors discussed here, are concerned with whatever you want; *its* subject matter is language and mind independent.

necessities hold only in some restricted set of possible worlds. Room is left within the unrestricted space of *all* possible worlds for cases in which like charges fail to repel each other, hence in which the law concerning charge fails to hold. For the modal necessitarian to simply deny that the *'must'* here is restricted in this sense would be question begging and so some independent motivation is required (Wilson 2013, 656). But independent motivation is indeed forthcoming.

According to Wilson, an explanatory burden is placed on the contingentist who maintains that natural necessity concerns only some restricted set of worlds. The burden is that of explaining why we are so concerned with the particular modality corresponding to the set of worlds with the same laws of nature as ours, i.e. natural necessity, and not with, say, the set of worlds in which wombats exist, corresponding to *wombat* necessity. An initial contingentist retort to this challenge will typically involve citing the correspondence between natural necessity and the breadth of humanity's scientific and practical interests. But this just pushes the demand for an explanation back a step because we can then ask why our interests should align in this way (this point, albeit framed slightly differently, was touched on in 6.4.1).

The modal necessitarian can meet this explanatory demand in a manner unrivalled in its simplicity: according to MN, natural necessity is necessity *simpliciter.* Our concern with natural necessity is thus explained by showing it to be a concern with necessity in the broadest sense and the question as to why we should be interested in some *subset* of possible worlds more than any other just no longer arises. So, Wilson suggests that we may properly motivate the claim that the *must* of natural necessity is unrestricted by citing the explanatory virtues thus yielded.

According to 'the argument from counterfactuals' laws *support* or *imply* counterfactuals. But if the laws are contingent, then the law according to which like charges repel, say, cannot support the counterfactual inference that two particular like charges *would* repel if they came into close proximity of each other because the law may fail to hold in the possible world under consideration. Schaffer responds along Lewisian lines, maintaining that sameness of laws is constitutive of the

closeness relation among possible worlds, which is in turn constitutive of the semantics of counterfactuals. On this view (roughly) a counterfactual is true iff at the *closest possible world* in which the antecedent is true the consequent is also true. And sameness of laws partially determines closeness. But again, this places an explanatory demand on the contingentist, one that the necessitarian will be able to meet with unrivalled ease. The question is: *why* should sameness of laws carry the weight that it does in determining closeness of possible worlds when evaluating counterfactuals? Wilson's concern with the typical Lewisian response touted by contingentists is that:

> Lewis simply assimilated the question of why the counterfactual construction incorporating his particular nearness relation should be of interest to us to the question of why laws should be of interest to us (Wilson 2013, 658).

As before, the necessitarian, by contrast, has a strikingly simple answer to the question of why counterfactual antecedents should point us to worlds with the same laws as our world – because the laws are metaphysically necessary![35]

For brevity, I'll just discuss two of Schaffer's five *direct* arguments against necessitarianism to which Wilson responds: the argument from counterfactuals and the argument from conceivability. But this should suffice to give an idea of the sorts of defensive strategies available to the modal necessitarian.

According to the argument from counterfactuals, the best semantics for counterfactuals requires the recognition of small *miracles* – local violations of the laws relative to the actual world (e.g., Lewis 1979). Without the possibility of small miracles, in *deterministic* worlds, counterfactual antecedents would require extensive backtracking to realise. For example *if there were a beer in my fridge I would drink it* is intuitively true. But to realise this counterfactual antecedent in a deterministic world, the initial state of the universe would have to have been

[35] As discussed, on my view the truths expressed in laws are metaphysically necessary, but for any law, L, it is possible that it wasn't a *law,* had our standards of strength and simplicity been different. This detail does not affect the present point.

different. So, it would also be true that *if there were a beer in my fridge, the past state of the universe would be significantly different*, which is intuitively false. And since (arguably) we don't know if ours is a deterministic world, we don't know if our counterfactual semantics has this unintuitive implication.

Miracles allow for widespread match in matters of particular fact between the actual world, @, and the world at which the counterfactual is evaluated, w1, up until some time, t1, at which a small miracle occurs, which brings it about that there is a beer in my fridge.[36] After the miracle at w1, the worlds diverge in as few respects as possible, consistent with there being a beer in my fridge in w1 but not in @.[37] Miracles thus allow for our intuitions about counterfactuals to be satisfied in deterministic worlds.

Wilson responds by claiming that MN is best twinned with a view of the laws of nature as involving quantum indeterminism (Wilson 2013, 661). 'Miracles' in the sense above can then be replaced by somewhat unlikely, but nonetheless physically possible, quantum 'quasi-miracles'. This response makes MN hostage to empirical fortunes, but this is something that Wilson is willing to accept, plus he takes it to be "extremely unlikely" that the world will turn out to be deterministic (ibid). Indeed, characteristic of MN is its denial of any pertinent conceivability-possibility link, which is central to the kind of modal rationalism that is being opposed. So, while empirical discoveries about the nature of quantum phenomena may harm MN, they may bolster it too. Since current evidence would strongly suggest that the world is indeterministic at the quantum level, MN gains plausibility. The fact that this plausibility is subject to empirical discoveries should not count against MN given that it is motivated by a desire to approach the metaphysics and epistemology of modality in a manner that is continuous with science. In other words, the charge that the tenability of MN is subject to empirical fortunes should carry no weight against the view because its proponents tout its sensitivity to actual science in its favour.

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[36] E.g. a law violation such that some neuron fires spontaneously while I'm in the supermarket, which makes me decide to buy beer.

[37] Is backtracking really so bad? Wilson considers the option of embracing widespread backtracking (Wilson 2013, 660, fn. 15).

The argument from counterfactuals is closely related to the problem of counterlegals. Many of the counterlegal statements formable in natural language, and common in scientific discourse, would seem to be substantive. But if the laws are metaphysically necessary, as MN would have it, then possible worlds semantics yields the result that all counterlegals are vacuous. However, Wilson contends that this apparent problem derives primarily from a limitation of possible worlds semantics – everyone is stuck with a class of counterpossible counterfactuals that cannot be given non-trivial truth conditions via possible worlds; the modal necessitarian just adds to this class (Wilson 2013, 661).

Lastly the argument from conceivability contends that the modal necessitarian's apparent severance of the conceivability-possibility link leads to modal scepticism. But this concern just misses the mark. Modal necessitarianism is in no small part motivated by a desire to reject the sort of archaic rationalism that motivates this worry. Metaphysical possibility is a matter of how the world could be, regardless of what we can imagine or what conceptual schemata we may employ. So why think that what we can conceive of, whatever that means, should provide any privileged insight into the modal nature of reality? Don't we frequently imagine impossibilities or take things to be possible which we later discover to be *impossible*?[38] For the modal necessitarian modal epistemology is continuous with ordinary epistemology and scientific epistemology in particular. Insofar as science is concerned with the natures of things in the world and the laws describing their interactions, it is science that provides insight into how things could possibly be. This line of thought is a common theme among commentators sympathetic to the project of assimilating metaphysical possibility to physical possibility.

7.3.4 Mutual Sensitivity of Metaphysics and Science

According to Callender: "metaphysics is best when informed by good science and science is best when informed by good metaphysics" (2011, 48).[39]

[38] That we may be subject to such *modal illusions* seems to be an important lesson from Kripke (1980), one which has inspired a vast literature on the proper way to account for such illusions (e.g., Yablo 1993; Chalmers 1996; Jackson 2000; Wright 2004).

[39] This sentiment and others expressed in this chapter are to some extent echoed by Paul, who in various places in her (2012) concedes the mutual sensitivity of metaphysics and science. But while Paul expresses some scepticism

Callender laments the post Kripkean turn taken by *some* metaphysicians who stake "exclusive claim" to the domain of metaphysical modality (Callender points to Conee and Sider 2005, 203 for an expression, though not necessarily an endorsement, of this idea). Callender is concerned with the reliability, source and subject matter of "modal intuitions" and suggests that intuitions of what is possible ought to make some contact with *science* (2011, 42).

Callender argues that it is a mistake to think of the metaphysician and the scientist as doing fundamentally different jobs and suggests that the subject matter of *science* is of primary relevance to the metaphysics of modality. Thus, science, concerned as it is with the actual world, and itself steeped in modality, replaces modal *intuitions* as an in to modal knowledge. The question of the reliability of our modal judgments is then assimilated to the familiar question of the reliability of the scientific method.

But, Callender's concern is not just with the *epistemology* of modality. It is rather with the relationship between science and metaphysics and their respective methodologies and subject matters, from which the above epistemological implications can be derived. So, it is worth taking a closer look at the considerations that motivate Callender's view.

Advances in modal logic and Kripke's (1980) influential defence of metaphysical necessity led to renewed interest in metaphysics during the latter part of the 20th century, before which scepticism about the legitimacy of the field abounded. Henceforth, Callender argues, metaphysics proceeded to primarily concern itself with modality. The question of the relationship between science and metaphysics then becomes largely a question of the relationship between science and metaphysical modality. Critical of the post Kripkean metaphysical turn (made by some) that apparently denied any pertinent relationship between science and the metaphysics of modality, Callender says:

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about *exotic* possibilia (2012, 20), she does not seem ready to concede the *identity* of physical and metaphysical possibility. But if, as I and the authors discussed here suggest, this identity claim yields significant theoretical fruit, then maybe it is something Paul should be open to given her explicit endorsement of appeal to theoretical virtues in the process of choosing between metaphysical theories.

> The error is thinking that the science of the actual world doesn't affect what one thinks is possible or impossible. The history of science and philosophy amply displays that what we think is possible or impossible hangs on science. (2011, 43–44).

The implication seems to be that those *things* that are the concern of science, the constituents of the actual world, ought also to be the concern of metaphysics (primarily concerned as it is with modality) because *they* are what is relevant to possibility and necessity in virtue of how they can possibly *be,* in some broad sense. The epistemological implication is thus that we can gain knowledge of modal truths via the scientific method, concerned as it is with the constituents of the actual world that ground metaphysical modality. When metaphysical inquiry proceeds purely via the investigation of our *intuitions*, it is ungrounded in this sense and risks becoming irrelevant to anything.

Of course, proponents of the (meta) metaphysics to which Callender is opposed will maintain that intuitions about metaphysical modality concern some wider domain than what is merely *physically* possible. Thus, these metaphysicians may hold that it is *metaphysically* possible for the actual world to be certain ways, broadly speaking, that are *physically* impossible. Callender, by contrast, *denies* that there is any interesting domain of metaphysical modality that is immune to science (2011, 44). He continues:

> Our modal intuitions are historically conditioned and possibly unreliable and inconsistent. The only way to weed out the good from the bad is to see what results from a comprehensive theory that seriously attempts to model some or all of the actual world. If the intuitions are merely 'stray' ones, then they are not ones to heed in ontology. *In metaphysics we should take possibilities and necessities only as seriously as the theories that generate them*. (2011, 44, original emphasis).

What we can gather from Callender here is the thought that where modal *intuitions* outstretch science, they should be given minimal weight (or no weight at all); intuitions are not serious theories in the sense quoted above. The reliability of these intuitions is simply assumed by the kind of metaphysics that takes itself to be fully autonomous from science. Callender maintains that a satisfactory answer to pressing questions about the reliability, source and subject matter of modal intuitions suggests a closer link between science and the metaphysics of modality, with the implication that there is really no species of metaphysical possibility that outstrips what is physically possible.

Turning to a specific example, Callender asks what it is about light that makes it true that it cannot travel faster than 299,792,458 m/s? Clearly it is not our *concept* of light, which we possessed well before the discovery of *light speed.* A natural answer presents itself; Callender suggests it is the *laws* of relativity that make this modal claim true. This raises the further question: what are laws? (2011, 45). Callender does not provide us with an answer and is content to point out that laws are central to our theories whose job it is to explain and systematize the world (2011, 45). What we treat as possible or impossible, Callender suggests, is a function of our good systematizations of the world and, by implication, the laws of nature. Callender is thus arguing that deriving the possible from our best scientific theories is a more principled approach to modal metaphysics than simply appealing to intuitions.

A question remains, however, about the relationship between the scientific systematization of the world and the possibilities. For the Humeans, modality will flow from the systematization, whereas for the anti-Humeans, the order of explanation will be reversed; the systematization will flow from modality in the sense that primitive modal facts will determine what constitutes a good systematization. Callender concludes that 'serious' (2011, 45) possibilities are tied up with our good (best?) systematization of the world, i.e., what is metaphysically possible is not independent of scientific theory. But he remains neutral on the ultimate source of modality (Humean or anti-Humean) and thus remains neutral on

the question of whether being connected to a good systematization of the world is constitutive or symptomatic of metaphysical possibilities (2011, 45).

This question about the source of modality is one with which I have been centrally concerned in this thesis. I have advocated a view according to which metaphysical possibility is a matter of how potencies – basic physical properties that are necessarily connected with dispositions, because they *ground* those dispositions – are *possibly distributed* throughout spacetime.

It was argued that to properly ground modality in the concrete constituents of the actual world in this way, an *unHumean* ontology of *potencies*, as opposed to a Humean, *R-quidditist* view of properties, must be accepted, otherwise one is forced to look elsewhere for the source of modality. If the Humean view is accepted, and the world is understood as a vast array of quiddities instantiated at point-sized space-time regions, then the actual world would seem to lack the resources to account for metaphysical modality and *this* has led Humeans to *outsource* modality to other possible worlds – a lamentable development in the eyes of many.

If we want to use science, concerned as it is with systematizing the world, as a guide to what is metaphysically possible, surely the world that science systematizes ought to be imbued with the resources to ground facts about metaphysical modality. The Humean world is not so imbued, so why think that science in a *Humean* world should be a good guide to what is metaphysically possible or necessary? If we want science, *qua* systematization of the world, to be able to guide us as to what is metaphysically possible, then the world to be systematized ought to have the resources to ground modality. The unHumean world of qualities that ground dispositions that I present in this thesis has these resources. My answer to Callender's question is thus that the good systematization of the world that science seeks, and which can serve as a guide to what's metaphysically possible, flows from the properties and their necessary connections to various dispositions, *viz*. *possible potency distributions*.

7.4 A Philosophical Justification for Heeding the Results of Science

A particularly controversial feature of the common ground view is the implication that physical and metaphysical modality are identical. What I hope to have shown in this chapter is that there are independent reasons for identifying physical and metaphysical modality, not least of all that doing so helps us respond to MYSTERY and EPISTEMOLOGY. So, it is in fact a virtue of the common ground view that it implies that physical and metaphysical modality are one and the same.

Perhaps, however, not everyone will be *so* concerned by MYSTERY and EPISTEMOLOGY that they are willing to make such a radical break from orthodoxy and *identify* physical and metaphysical modality in order to resolve these issues. It is also likely that a great many philosophers will be less convinced than myself and the authors presented in this chapter by the thought that the results and methods of science ought to inform metaphysical inquiry.

But unlike the authors presented in this chapter, I have sought to justify the identification of physical and metaphysical modality and hence the use of scientific methods and results as a guide to metaphysical inquiry by building up to this conclusion from a relatively modest and uncontroversial starting point. I argued that there are good reasons to deny R-quidditism and, hence, to maintain that properties are necessarily connected with various dispositions. From here it was argued that this view of properties is naturally wedded with a very appealing metaphysics of modality – hardcore actualism (HA) – according to which all modal truths are grounded in the concrete constituents of the world. An attractive way of further fleshing out HA and of thinking about the relationship between properties and modality is that metaphysical possibility is a matter of how fundamental properties, or *potencies*, are possibly distributed throughout spacetime. I also argued that the laws of nature are features of a description of possible potency distributions, a description which presents this information about how all potencies are possibly distributed in a way that is useful and accessible *to us*. From this it follows that scientific inquiry into the laws presents our best route to knowledge of what is metaphysically possible. The epistemology and metaphysics of metaphysical modality are thus demystified – metaphysical modality is a matter of

how familiar physical properties are possibly distributed and *science* presents our best route to *knowledge* of such things.

My view thus answers MYSTERY and EPISTEMOLOGY and justifies appeal to scientific methods and results in the course of philosophical inquiry in a very principled manner. The picture I develop has a modest starting point: the denial of R-quidditism, which perhaps even one who is less concerned by MYSTERY and EPISTEMOLOGY and by the promise of using scientific methods to gain philosophical insights could accept. A potential concern that one may have with the sorts of sentiments expressed in this chapter is that they are rooted in a kind of scientistic prejudice or a scepticism about philosophy and hence that assent to them constitutes something of a rejection of the distinctive philosophical method.

However, from this thesis, it should be clear that one can accept the conclusion that science can guide philosophical inquiry without thereby denouncing philosophy. After all, to arrive at this conclusion I have employed distinctively *philosophical* arguments and methods. Indeed, what I have sought to do is build something of a philosophical system that comprises accounts of the metaphysics of properties, laws and modality, and which elucidates these important philosophical concepts and the relations between them. If it is an implication of this system that science can guide philosophical inquiry, this should not be seen as undercutting philosophy but rather as an interesting and appealing philosophical conclusion in its own right.

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